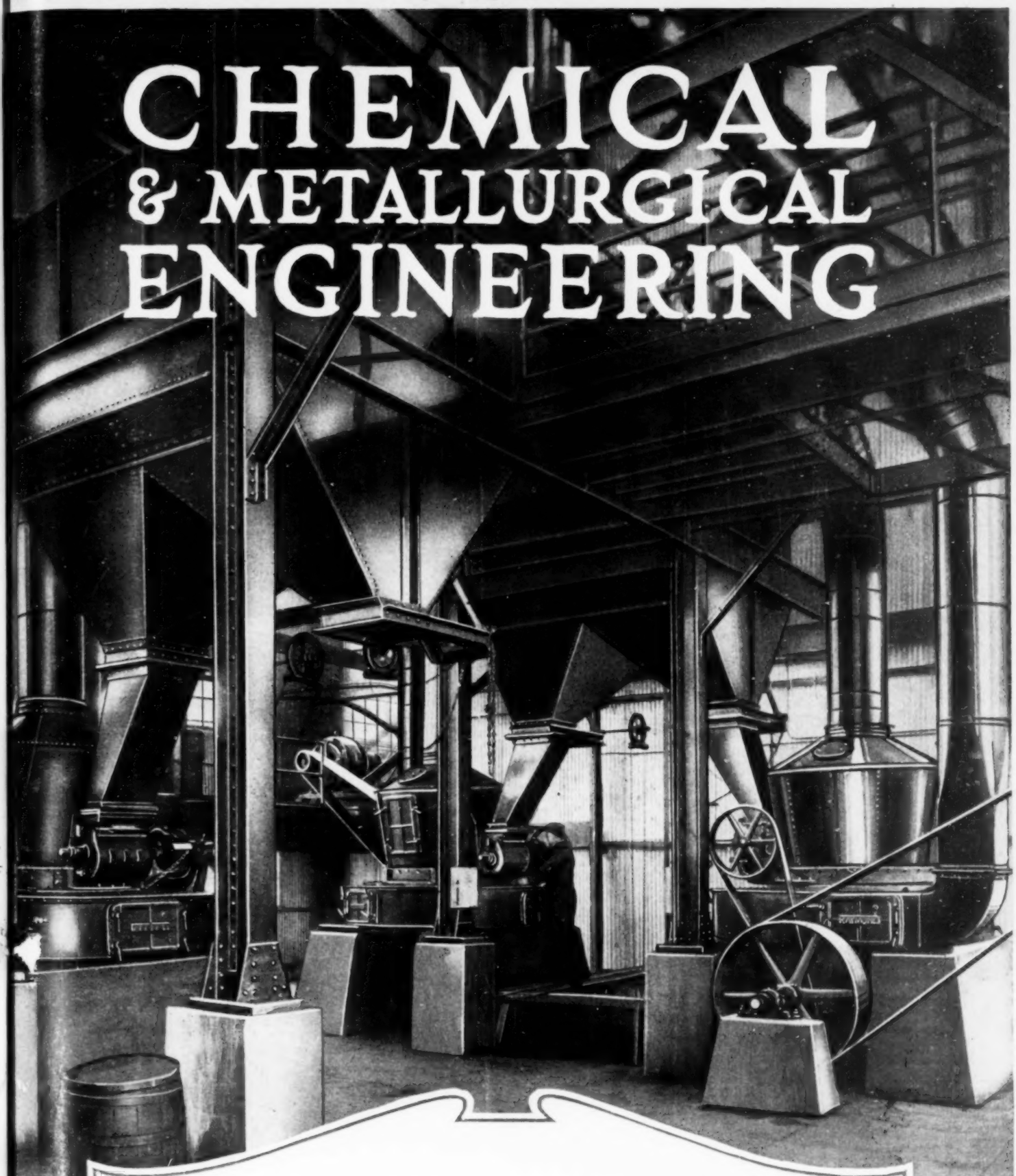
CHEMICAL & METALLURGICAL ENGINEERING



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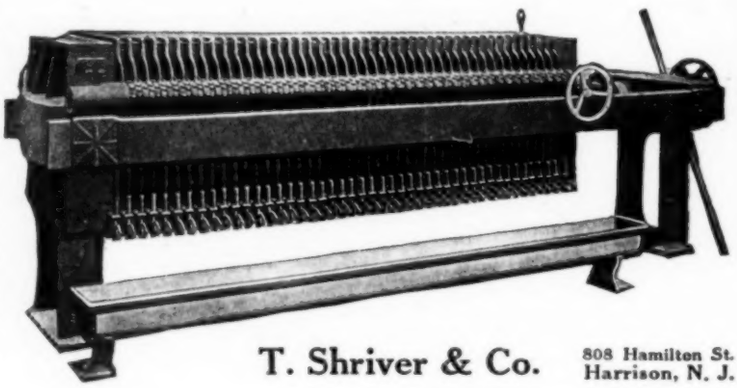

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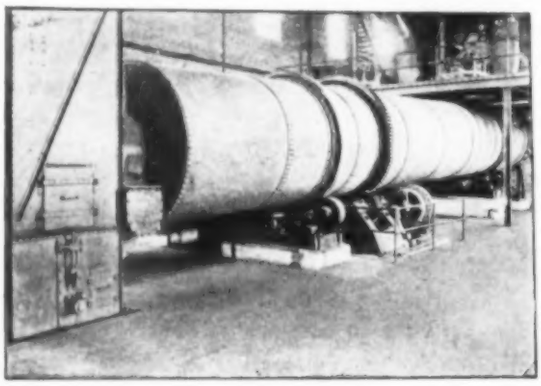

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
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Volume 23 New York, October 20, 1920 *Number* 16

The Long Road to Scientific Control

THERE has been organized a Canadian Society of Technical Agriculturists at Ottawa, and at the first convention, held in June, Professor W. P. THOMPSON, of the University of Saskatchewan, addressed the members on Scientific Research in Relation to Agricultural Problems. The address was printed in the October 1 number of *Science*.

The purpose of the association is to foster and develop the application of science to agricultural industry. The difficulties are many, despite the immense efforts that have been made, both here and abroad, to make of farming a real profession. The public at large, as Professor THOMPSON points out, thinks chemistry, for instance, a highly complex and mysterious study, capable of performing all sorts of wonders, whereas nearly every one thinks he understands agricultural operations. Now agricultural problems are as complex as those of any other industry, and progress is possible only through the application of scientific facts and principles by those who have been properly trained. The scope of necessary research is no less than immense. It involves the physics, chemistry, biology and geology of the soil, physiology and pathology of both plants and animals, systematic biology, entomology, foreign plant introduction, genetics, bacteriology, mechanics, climatology, sociology and economics. It makes the operation of a blast furnace, for instance, look like a scientific toy; and nobody complains that the operation of a blast furnace is too easy. There is so much to do, or to put it a little differently and yet to mean the same thing, our present ignorance is so general and all-encompassing that a mere list of the sciences involved looks impractical. It certainly is enough to frighten anybody who owns a farm.

Nevertheless, the benefits which already accrue as the result of research in agriculture are not surpassed by those of any other industry, although the real study is hardly more than begun. The day may come within the next generation when some other method of settling labor difficulties will take the place of the strike, and as soon as this happens industrial, large-scale farming with its own warehouses, its villages, its transportation systems for labor, etc., will probably become profitable, because scientific control, properly applied, always pays. And scientific control in farming involves the co-ordination of many trained minds.

In the meantime other industries less complex in their nature and requirements had better provide for scientific control—or else look for the road that leads into the tall timber. Who would now undertake to produce iron from ore with an old furnace doctor to judge materials by "the look of them" and to dose the furnace with secret medicines when trouble appears? Where will the automotive industry be unless more liquid fuel of the right kind is developed to operate the engines? But cracking petroleum is a simple problem compared with the long list of things yet to be done on the farm. The rubber industry has made a start. Some tanners, but far from all, have begun to see the light. A few iron founders are scientific, but more are not. Only a few years ago makers of brass were enlightened by Egyptian traditions, and they had little inspiration of later date. A large part of the ceramic industries is still operated under the rule of thumb. The enlightenment of science in industry is only beginning; just beginning.

Metallic Oxides Soluble in Steel

WHILE a great deal of the space occupied by Messrs. RAWDON, GROESBECK and JORDAN in this issue is devoted to a study of nitrides in arc-welded iron, one very suggestive remark about oxides is made which may be worthy of rather more emphasis. Following MILLER and COMSTOCK, the present authors have labeled "oxide" the small rounded spots occurring in the micrographs, which spots, by the way, are identical in appearance with those in vacuum-fused electrolytic iron of high purity, but oxidized on the surface before melting. Whether the spots are FeO—a compound whose very existence is questioned—higher oxides of iron or more complex mixtures of various metallic oxides and silicates is not known, nor can such problems be solved without much more experimental information than is available at present.

The notable fact developed by our present contributors, however, is this: That whenever arc-fused iron was heated to 1,000 deg. C. in a relatively high vacuum for several hours there resulted a great decrease in the number of small rounded inclusions originally present, together with a marked increase in size of the still remaining ones. Here is the first instance coming to attention of the migration of non-metallic inclusions. As pointed out recently in these columns, no one ever has affirmed such movements, and many have testified they have looked for it without avail. WHITELEY, at the fall meeting of the British Iron and Steel Institute, in vainly attempting to remove deep-seated oxide spots from ingot iron by annealing in hydrogen, says: "No indication of such migration [of oxide inclusions to the surface] occurring to any appreciable extent was observed in a strip after it had been heated *in vacuo* for three hours at 1,050 deg. C." Yet RAWDON and his collaborators present undoubted evidence of changes in the disposition of insoluble oxidized inclusions. Such movement, we take it, involves a certain solubility of the oxidized particle in the hot solid metal. The authors

do not agree to this inference, but their view expressed in correspondence, that "during the agglomeration of the originally small ferrite grains during the stay above A_3, the oxide inclusions in the various and adjoining small ferrite grains were in some unexplained manner brought together to form a single and larger inclusion," appears to be only another way of saying that the grains were observed to be larger after heating. MAHIN'S work also has a tendency to show that non-metallic inclusions are slightly soluble in solid ferrite.

Oxygen has popularly been held to be of utmost danger to sound steel. Volumes have been written about refining operations in bessemer and open-hearth, and about blowholes and dead-melted steel, much of which involves the ultimate assumption of the presence of quantities of oxide in the metal. Yet ROSENHAIN says that it is extremely doubtful whether iron oxide is soluble in molten iron—notable constancy of results which various investigators have reported for the melting point of pure iron is strong support of this idea. In this connection it may be noted that evidence of the insolubility of FeO in liquid iron is pretty good evidence of insolubility at lower temperatures because of the well-established rule that "solubility decreases with lowering temperature."

It is quite unfortunate that we have no precise quantitative method for determination of oxygen in steel, and our knowledge of the nature of non-metallic inclusions is but scanty, consequently it has been possible to infer that iron oxide is insoluble in solid metal only from the fact that oxidized inclusions are unaffected by ordinary heat treatments. Yet several recent researches, including the one printed in this number of CHEMICAL & METALLURGICAL ENGINEERING, have thrown doubt upon this popular supposition.

Thus, HUMPHREY found that pure iron heated in air acquired a superficial layer of oxide but apparently was not otherwise affected. If the oxygen pressure was reduced to less than 10 cm. the surface was oxidized only in spots after annealing at 1,000 deg. C., yet the piece acquired great intercrystalline brittleness, a defect which could be cured by annealing in hydrogen, or by heating above Ar_3 and quenching. To explain these facts he assumed two kinds of oxides—the ordinary scale, which is insoluble, and an embrittling sub-oxide, which collects at the grain boundaries—even though invisible under the microscope—and which is soluble in gamma iron. MILLER explains the brittleness of fusion welds and its cure by a reducing anneal, by the same "invisible oxides." LE CHATELIER and BOGITCH more recently maintain that the macrostructure revealed by STEAD'S reagent is due to oxygen distribution rather than phosphorus, while MCCANCE goes further and ascribes the micro-ghost lines to oxygen, since this appearance can be destroyed by hydrogen at 1,000 to 1,100 deg. C. (supposedly without difficulty), yet the phosphorus analysis shows no difference. WHITELEY has also proved that micro-ghost lines persist in areas where uniform distribution of phosphorus has been attained, and therefore must be due to some other substance which diffuses with extreme slowness at temperatures below 950 deg. C.

These researches all appear to indicate that there is one extremely tenuous and extremely dangerous oxide commonly observed in steels, besides the well-known and relatively less harmful particles of scale, slag or mixed reaction products. The latter seem to be reduced to metal with extreme difficulty by a hydrogen anneal, while the former, either by reason of its existence in solid solution or by reason of a different composition, reacts much more readily with occluded hydrogen. Under certain circumstances the insoluble oxide apparently may pass into a soluble modification and again revert to insolubility.

Even though one might disagree with MCCANCE that much of the bad reputation of sulphur and phosphorus is due to FeO in the steel, and with GIOLITTI that the phenomenon of transverse fragility is largely enhanced by oxidized inclusions in the steel, it behooves all of us to turn our attention to the many unsolved problems collateral with this recently raised query regarding soluble metallic oxides in steel, their origin and prevention, their effect and cure.

A Thermal Flow Sheet

IN CERTAIN industrial operations it is common to strike a weight balance and a heat balance at appropriate intervals in order to check up on otherwise unsuspected losses. However, this program apparently is not as widely followed in chemical industry as is desirable. If every source of energy is taken into consideration, and the ways in which this energy is used or dissipated ineffectively are recorded regularly, means are often suggested for correcting losses that have not previously been noted.

One can take as an excellent example of the need of thermal analysis the problems connected with the coking of a ton of bituminous coal with production of coke and byproducts. The figures reported recently on the coking of Illinois coal illustrate the importance of this problem. Two thousand pounds of this material averaging 12,500 B.t.u. per pound gives 25,000,000 heat units to account for. Approximately 1,400 pounds of coke of a heating value of about 11,000 B.t.u. per pound accounts for approximately 62 per cent of the original heat available, or, to be exact, 15,400,000 B.t.u. The five and one-half "M" of surplus gas formed would account for approximately 3,100,000 B.t.u. The eight gallons of tar averaging perhaps 140,000 B.t.u. per gallon represents 4½ per cent of the original heat, or, roughly, 1,100,000 B.t.u. Slightly less than four gallons of light oil having about 135,000 B.t.u. per gallon represents 2 per cent more of the original heat, or a little over 500,000 B.t.u. In these products and the ammonia we find about 85 per cent of the heat originally in the coal. The remainder has been consumed in the processes. To be exact, the test referred to showed that 1,430 B.t.u. was used for the coking of each pound of coal as charged to the battery. The analysis of heat dissipated by radiation from the battery, sensible heat in the gas, sensible heat in the coke as pushed from the oven, and heat carried off in the flue gases from the heating chambers of the ovens would be very enlightening to show what has become of this amount of heat, which represents more than 10 per cent of the total originally available. To a certain extent such analyses have been made, but by no means as many such studies of the industrial processes in general have been accomplished as would seem to be well worth while.

Energy these days costs too much money to waste, even if purchased in the form of the cheapest bituminous coal. The chemist, being thoroughly familiar with the physical changes and thermal relations of various stages of the process, may well apply himself to problems like

this. In any industry that is well standardized, the variations in process are often most clearly pointed out by such study. In new industries means for improvement in efficiency are quickly discovered. In other words, no matter in what stage the industry may be, the thermal study will be well worth while.

In such a study, however, great accuracy may not usually be possible. This, however, is no excuse for omitting attention to the subject. We need more data as to heat conductivity and heat capacity of materials of construction as well as for materials entering into the processes themselves. Without such data an accurate analysis of heat utilization and wastes can, of course, not generally be made. Conditions in this respect are, however, continually improving and increased attention to the application of thermal chemistry will accelerate our investigations of thermal data quite to the advantage of both the industry and the investigations.

Steel Production And Processes

THE steel production statistics for 1919, just made public by the American Iron and Steel Institute, furnish some interesting information as to the vogue of the various producing processes. The amount of production as a whole has been fairly well known since the end of the year through the medium of trade estimates. The output of ingots was 33,694,795 tons, against the record output of 43,619,200 tons, in 1917, and against a capacity that may be estimated at about 52,500,000 tons, which is 50 per cent above the estimated capacity in 1914, when the war began. Thus the output was only about 64 per cent of capacity, but at that it was 11 per cent in excess of the output in 1912 and 1913, the two best tonnage years before the war.

The output of steel castings did not make as good a showing as the ingot output, being 976,437 tons in 1919, against 1,441,407 tons in the record year of 1917 and 1,020,744 tons in 1913, the best year before the war.

The output of rolled material amounted to 24,042,093 tons of rolled steel and 1,059,451 tons of rolled iron, making a total of 25,101,544 tons. The output of rolled iron was the smallest for many years, and was only half the output in 1905, 1906 and 1907, when the wrought iron industry experienced a redivivus. It was about the year 1892 that the production of wrought iron began to decline, there having been growth previously even though the new material, "soft" steel or "mild" steel as it was then generally called, was making great inroads.

The proportion of rolled steel to steel ingot production has undergone some interesting changes. The percentage has been as follows:

1908	77.5	1914	75.4
1909	77.0	1915	70.2
1910	79.0	1916	73.8
1911	76.3	1917	71.6
1912	76.0	1918	68.6
1913	76.4	1919	71.5

A mere scrutiny of the table would suggest that American steel manufacturers have grown progressively more wasteful, producing more scrap and scale before arriving at the finished rolled material. For the earlier years in the table it is to be remarked, however, that previous to 1912 the semi-finished steel exported was not ascertained and thus some steel was lost in the statistics, though there was no pecuniary loss to the works. The drop in the percentage during the war years was doubtless caused by the heavy cropping involved in the manufacture of shell steel, and this influence appeared in the production of steel for forged shells, since rolled forging blooms and billets are reported as rolled steel output. As for the low percentage in 1919, that is doubtless to be attributed to labor inefficiency. A return to approximately a 76 per cent proportion is to be expected.

The vogue of the duplex process has not increased as much as was expected. The tonnage of "duplex" steel reported, as part of the basic open-hearth output of steel ingots and castings, and the percentage the tonnage comprised of the total basic open-hearth steel output, are shown below:

	Duplex, tons	Percentage
1912	1,438,654	7.3
1913	2,210,718	11.4
1914	835,690	5.1
1915	1,781,491	8.0
1916	3,436,457	11.6
1917	3,791,830	11.8
1918	3,870,017	11.9
1919	2,819,785	11.0

If, however, the steel works had had as much difficulty in the past few years in securing scrap as it was predicted years ago would be the case, there would have been much more employment of the duplex process than is shown, for 11 per cent is no high proportion for the duplex process.

Electric steel makes an excellent showing for 1919, the production, in ingots and castings together, being 384,452 tons, this being the largest output on record outside the 511,364 tons produced in 1918, largely against certain special war requirements.

Two Hundred Academic Ambassadors

GERMANY is planning to continue her ante-bellum practice of exporting scientists stamped with the familiar mark "Made in Germany." Dr. CHARLES SOLF, after ninety days of Ambassadorship in Japan, has established cordial relations and obtained an invitation from Marquis OKUMA for two hundred Herr Doktors to spend their time in Japan, each receiving $10,000 per annum. Two million a year is said to be cheap for the service Japan expects to receive. Half of the Ph.D.'s will be placed in the universities. The others will be engaged in industrial research and development work.

Conditions in Germany are without doubt bad. Many eminent scientists and engineers there cannot obtain remunerative occupation and must emigrate either from their profession or from their country. By going to Japan under the able leadership of Dr. SOLF they can escape the first alternative and technically avoid the second. They will be part of the German Embassy, so to speak, and will function with due regard to the rules of Berlin diplomacy. The doctrine of German supremacy will be taught first, last and always. Science will be gesprochen und gelesen while Kultur is taking root. Japan may get her two million dollars worth of science yearly but if she has to pay the price of subjection to a foreign leader in scientific thought in addition she will be the loser. However, all other nations will owe her a debt of gratitude for harboring this horde of academic ambassadors, for they certainly will build an undesirable propaganda system wherever they go.

Notes on French Industries

FROM OUR PARIS CORRESPONDENT

Paris, France, September 15, 1920.

THE industrial situation in France will continue to be precarious as long as the coal question is unsolved.

Before 1914 France had to depend on import for 40 per cent of the needed fuel; today its dependence is more accentuated due to the destruction during the war of the greater part of the coal mines in the fighting regions. France needs now annually at least 76,000,000 tons, this being the tonnage used during 1913. As the country is expected to produce only 24,500,000 tons, the remaining 51,600,000 tons—i.e., more than 73 per cent of the fuel needed—must be imported. With Germany supplying 19,000,000 tons, Great Britain, United States and Belgium about 15,000,000 tons and 5,000,000 tons from the Saar district, France will have only 63,500,000 tons instead of the 76,000,000 tons needed. The deficit of 12.500,000 tons works great hardship especially on the chemical and metallurgical industries. It is hoped that the government will find a way to remedy this shortage of coal.

HYDRO-ELECTRIC INDUSTRY

The chemists and metallurgists have great hopes that the development of the French hydro-electric power will alleviate the fuel shortage. It is estimated that one hydro-electric horsepower is equivalent to five tons of coal. The country is very rich in waterfalls, especially in the regions of the Alps and Pyrenees. It is estimated that there is available 10,000,000 hp., of which 5,000,000 might be used for the industries. Of this only 2,550,000 hp.—i.e., 1,800,000 kw.—will be in use when all the work now under construction is completed. This figure could easily be doubled if the government would do its share to facilitate development by according concessions and hastening the reclaiming work.

It is safe to state that the present investment in the French hydro-electric industry amounts to over one billion francs. Further water-power developments require vast capital, especially when it is considered that instead of the 500 to 800 fr. pre-war cost per horsepower developed, the post-war cost is from 1,000 to 1,600 fr. Money is not scarce in the country, but the French capitalists are timid and not enterprising. They prefer to stick to the old custom of keeping the greater part of their wealth in cash and investing the remainder in bonds and shares securing them a fixed revenue. It is also a fact that the farmers have grown rich during the war and still continue to grow rich. The French farmer working his small piece of land by the rudimentary methods of a hundred years ago earns enough and does not care to become interested in the industry of the country and in the resulting progress in agriculture.

ALSATIAN POTASH

The annexation of Alsace resulted in France having now the petroleum it needs from the Pechelbrom oil field and the rich potash mines of the Mulhouse district. The potash lies at a depth of about 600 m. in two seams, one of an average thickness of 3.5 m. (about 11 ft.), the other of about 1 m. (about 3 ft.). It is estimated that there is a reserve of 300,000,000 tons of pure potash. Unfortunately the working of the mines was not as active as it ought to have been, due to the difficulties resulting from the uncertainty as to the definite allotments of the mines. The solution lately arrived at is the buying of the mines by the French Government and the leasing to responsible persons or concerns. The government paid 150,000,000 fr., but this sum is simply to mark the entrance in possession; the real value of the mines is estimated to be between two and three billion francs. The leasers, it would seem, will have to abide—in a certain degree at least—by the desiderata formulated by the workmen for the nationalization of the mines. It is to be hoped that the French administration will not lose much time in placing the mines in actual and extensive working order.

SYNTHETIC AMMONIA

Up-to-date agriculture would afford a great market for synthetic ammonia. Georges Claude is working now on its production by a process[1] differing from that of Haber in that he uses 1,000 atm. pressure instead of Haber's 200. France requires yearly about 100,000 tons of ammonium sulphate.

THE FRENCH DYESTUFF INDUSTRY

The Compagnie Nationale des Matières Colorantes, founded with the moral support of the French Government, which has put at the disposal of the company the powder plant of Oissel (near Rouen), for the first time since its foundation in 1917 has declared a 5 per cent dividend. The company, with which is consolidated the Société des Colorants Français, is now capitalized at 71,000,000 fr.

The most important product manufactured by the company is synthetic indigo, the production being more than 200 tons per month, of which a great part is exported to the United States.

Other products manufactured are direct cotton dyes and acid dyes for wool, and sulphur dyes. The company is working on a program for the manufacture of basic and anthraquinone dyes. It is expected that this program will be in working order by 1921.

The total production of the French plants of various dyes is at present about 600 tons per month, say in round figures about 7,000 tons per year. The French consumption, including that of Alsace and Lorraine, is estimated to be 12,000 tons per year; this shows that much is still to be done in the dye industry to make the country independent of foreign dye products.

The French manufacturers are directing their activities toward the production of special dyes.

Coal and Coke Production in the Saar District During the First Half of 1920

The production of the Saar mines during the first half of 1920 is given in the following table:

	Coal, Metric Tons	Coke, Metric Tons
January	727,465	18,224
February	743,063	18,292
March	839,874	20,141
April	734,665	19,099
May	709,766	18,571
June	763,616	19,676

At the end of June the entire personnel consisted of 69,056 miners and 2,573 engineers and other employees. The net production of coal per man per day reached 470 kg. (about 1,030 lb.).—*Echo des Mines et de la Métallurgie*, Sept. 10, 1920.

[1] See CHEM. & MET. ENG., vol. 23, No. 9, Sept. 1, 1920, p. 395.

Foundrymen and Institute of Metals Meeting

Reports on Papers Presented at the Columbus, Ohio, Annual Joint Meeting of the American Foundrymen's Association and Institute of Metals Division of the Mining and Metallurgical Engineers

THE American Foundrymen's Association and Institute of Metals Division of the Mining and Metallurgical Engineers held their annual joint meeting in Columbus, Ohio, Oct. 4 to 8. As is their custom, an exhibit of foundry equipment was also held at the same place, occupying seven of the group of permanent buildings erected on the State Fair Grounds. As pointed out by the president in his annual address, it has rapidly become a problem how to handle this very desirable adjunct to the annual meeting. There is a constantly growing number of applications for space, and it does not seem possible to restrict the amount allotted to each exhibitor. It is the policy of the organization to hold the general meetings in different cities, so that every so often a meeting is held in each section of the country, yet there are few cities which have the necessary exhibition space for a show such as the Foundrymen now stage. Or, given the exhibition space, hotel accommodation for the large number of visitors may not be available, as indeed was the case at Columbus. Lucky were they who were accepted by a hotel—those who came from a distance and wished to stay for more than a day had to scurry around town for accommodation in a private residence.

Simultaneous sessions of the two main organizations, with a meeting of the Electric Furnace Association and a continuous performance at the exhibit, made it rather hard for the man in attendance to be in as many places as he would like. On page 769 of this issue will be found the proceedings of the Electric Furnace Association. Hereafter will be given notes on several papers appearing before the Foundrymen and Institute—subsequently also we hope to give a full account of a very interesting session on Malleable Iron. Little mention will be now made of some important papers read before a session devoted to metallography and general subjects, reserving them for presentation in future issues.

In general, it may be said that the technical sessions were well up to their previous high standard, and in many respects excelled. Particularly noticeable was the large attendance of interested men at all the meetings. As a guarantee of continued improvement in the quality of its transactions, announcement was made at the banquet of the establishment of a fund of $21,000, presented to the Foundrymen's Association by five donors, the income of which is to be awarded to the authors of the best contributions on certain phases of the industry.

Social events of the sort which have come to be expected of the annual event—plant visitation, golf tournament, smoker and banquet—were enjoyed by the members journeying to Columbus. Unfortunately, however, it is a Presidential year, and the committee on arrangements seemed to have forgotten that all who must listen to the speeches might not be of their political faith!

Meeting, American Foundrymen's Association

THE opening session of the American Foundrymen's Association was to receive a number of papers on Gray Iron, but after reading his short paper giving a few experiments using 30 per cent ferrozirconium as a deoxidizer, the meeting became a class in elementary principles of cupola practice, with Dr. Moldenke as instructor, even continuing all afternoon. All his ideas radiated from a main thesis that there were three essentials in good foundry practice, neglect of any one being fatal to the final result. First, one must start with good materials; second, melting practice must be correct; and third, proper gating of the molds must be provided. Defects not obviously due to slovenly workmanship could always be traced to one of these three steps.

George K. Elliott, of the Lunkenheimer Co., presented a brief note drawn from his experience in refining cupola-melted iron under a carbide slag in a basic electric furnace. Sulphur may be reduced from 0.13 to 0.05 in from forty minutes to one hour, depending upon the condition of the slag and the furnace atmosphere. Cost is largely for electricity. Current consumption in such a run would be from 200 to 350 kw.-hr., depending upon the time and superheat required, and the entire cost would range from ¼c. to ½c. per lb. iron. In return for this, the castings, especially if small, machine easier with a large decrease in defectives; transverse test bars are 50 per cent stronger (tensile tests about the same); and carbon is under closer control. Mr. Elliott suggests that a large share of these advantages is due to deoxidation rather than desulphurization. A sulphur content of 0.05 or even 0.07 is in practice now handled so as to be harmless. In other words, one would be unable to fix positively any pronounced advantage in gray iron castings with 0.03 per cent sulphur, due to this low content exclusively. On the other hand, since sulphur has such a tendency to segregate, 0.15 per cent sulphur will harm cast iron much more than three times as much as will 0.05—more like three times three. So well known is this that high-sulphur iron in good service is occasion for remark. Extremely low sulphur, 0.02 per cent, on the other hand, would be chiefly valuable in the assurance that one is far below any danger from this metalloid. A more natural use for foundry duplexing is the production of say 0.06 sulphur castings from 0.15 mixes, a practice which is easily and demonstrably economical in these days of poor coke, costly freight and high sulphur scrap. Electric-refined iron is materially harder than cupola iron from which it is made, more especially when made into small castings. This is largely due to the fact that the manganese otherwise used in making sulphide now exists as carbide, which is a hardener. "This question of hardness is intermingled with the closely related subjects

of the increased attraction of high-manganese irons for carbon, and of the protective influence of high manganese against oxidation in the cupola."

Castings for Machine-Tool Builders

Two interesting talks on making castings for machine-tool builders were given by L. M. Sherwin, of the Brown & Sharp Manufacturing Co., and A. N. Kelley, of the Modern Tool Co. Such castings are seldom produced in large quantity, and, like most others, are made by more or less unskilled men, yet they must be of very high grade, for they are bought by men who know good castings when they see them. A large proportion must be finished all over, so that the slightest porosity would be ruinous. Tables, columns and arms must not warp; must have a fine grain and take a high finish; must be hard to resist wear yet not so hard as to give difficulty in machining. Much of the molding—even to the core making—is done by machines. Green sand molds, properly made of carefully selected sand and faced with 7 to 1 sand and sea-coal mixture, have been very successful. When chills are necessary, they should be sectional, separated somewhat one from another—large chills warp badly and have a very short life. For green molds chill blocks should first be washed with linseed oil, sprinkled with silica sand, and then baked in a core oven. Cupola mixtures must be carefully maintained, and the melting so done as to produce hot clean iron. A siphon tap and mixing ladle are advantageous, but even then special attention must be given to skimming the pouring ladles carefully. Long, flat castings may be poured simultaneously from both ends through horn gates—such rapid filling insures hot iron in all parts of the mold. Another method is to incline the mold so that the flat surface is tilted at about 6 deg. (gated at the lower end). This prevents the iron thinning out and chilling in layers.

Heat Treatment of Steel Castings

A meeting devoted to Steel Castings paid considerable attention to complex heat treatments to produce special qualities. Steel founders in general think of heat treatment as meaning annealing to break up ingot structure. The possibilities of more complex treatments—normalization at various temperatures, drawing or tempering at various temperatures, and quenching at different speeds from different heats—are by no means realized as yet, and a great amount of educational work on fundamentals will be necessary to establish the heat treater in steel foundries. Such papers as that by Fred Grotts, of the Holt Manufacturing Co., will therefore do much to open the eyes of steel founders to the possibilities of their materials, and may also cause the forge-shop men to look to their laurels.

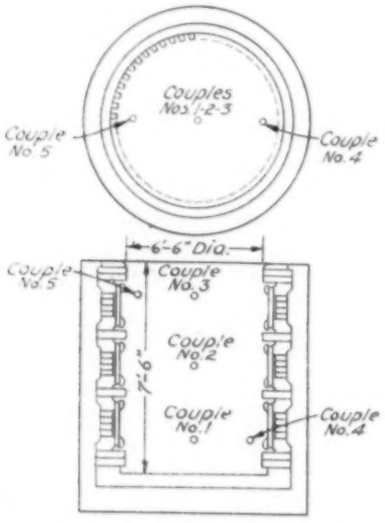


FIG. 1. TEST DATA SHOWING HEAT UNIFORMITY OF ELECTRIC FURNACE

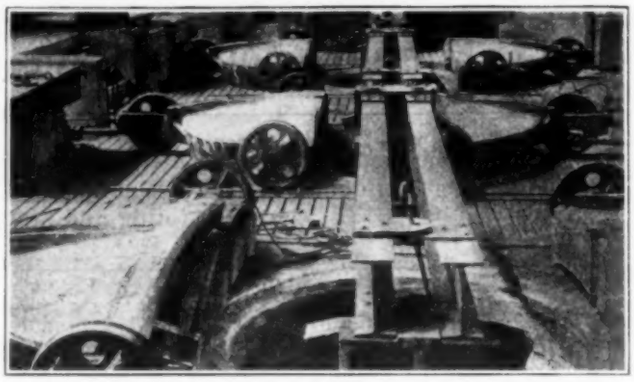


FIG. 2. BATTERY OF THREE VERTICAL ELECTRIC HEAT-TREATING FURNACES FOR GUN FORGINGS

C. H. Gale, of the Pressed Steel Car Co., produced some interesting figures on the absorption of carbon and sulphur when annealing 0.26 carbon steel castings with pulverized coal (2½ per cent S). While no details of the furnace, method of burning, or analysis of furnace atmosphere were shown, the author gives chemical tests tabulated in Tables I and II.

TABLE I—CARBON AND SULPHUR ON REPEATED ANNEALING

	Original Analysis	First Anneal	Second Anneal	Third Anneal	Gain
Carbon	0.265	0.291	0.317	0.326	0.061
Sulphur	0.042	0.052	0.055	0.056	0.014

TABLE II—CARBON AND SULPHUR IN SURFACE LAYERS AFTER FIRST ANNEAL

	Original	⅛ In. Deep	¼ In. Deep	½ In. Deep	¾ In. Deep
Carbon	0.286	0.298	0.293	0.288	0.285
Sulphur	0.046	0.055	0.052	0.049	0.047

These results were sufficient to convince the author that increased tensile strength but decreased ductility and transverse bending were due to the change in chemical composition.

Some data on the operating costs and the temperature distribution in vertical furnaces heated by electrical resistors of looped metallic ribbon were given by E. F. Collins, of the General Electric Co. Fig. 1 is a sketch of a moderate sized automatic furnace of this type, and a temperature survey given in Table III shows a remarkable uniformity. Fig. 2 gives a view, with covers rolled back, of a battery of three such furnaces

TABLE III

	Thermocouples—Temp. Deg. C.				
Time	1	2	3	4	5
11:30	25	25	25	25	25
3:30	527	537	532	530	545
7:30	670	679	671	666	669
11:30	777	783	776	766	780
3:30	858	864	857	849	864
7:30	860	865	862	862	863
11:30	928	934	930	930	928
3:30	933	932	927	925	927
4:30	950	950	952	952	955

6 ft. diameter by 25 ft. deep. Average furnace charge was eleven tons, which was heated uniformly to 1,450 deg. F. with the expenditure of 178 kw.-hr. per ton. After quenching, the forgings were drawn at 1,150 deg. F. in similar furnaces with the expenditure of 85 kw.-hr. per ton. Both heatings together cost $2.23 for power (rate = $0.0085 per kw.-hr.). Total cost of heat treatment on 24-hr. operating basis for the month before the armistice totaled $2.76 per ton.

Institute of Metals Sessions

A STUDY of Brass Foundry Fluxes was presented by C. W. Hill, T. P. Thomas and W. B. Viez of the Westinghouse Company. Such fluxes are added to molten metals preparatory to casting, in order to remove small amounts of impurities introduced by the melting process. Popular materials are NH_4Cl, $ZnCl_2$, NaCl, and borax. Chemically the chloride flux is supposed to effect double decomposition with dissolved or admixed oxide, or to be reduced by the metal itself. However, the authors have been able to cause good fluxing of finely divided aluminum particles by adding aluminum chloride, which is the reaction product of any possible chemical interchange with contained chlorides, and which is itself without any chemical action on the metal or its oxide. Careful tests on molten aluminum have given the same chemical analyses both before and after fluxing, yet the physical effect is marked and extremely rapid. The authors conclude, therefore, that the action is largely physical or mechanical, and suggest that perhaps rapid evaporation of the flux at the points of contact with the surface film may burst this film, allowing the molten particles to unite. Gillett has caused complete coalescence of hot particles by pressure and heat, using no flux whatever. A secondary action of a flux may also be the partial or complete solution of the surface films in the flux before its volatilization.

Fluid covers are supposed to prevent gas absorption—borax, in addition, will dissolve metallic oxides which reach the metal: flux interface. However, most of the common coverings are permeable to hydrogen, which indeed easily passes through a hot crucible wall. In this connection the same authors have studied the solubility of hydrogen in molten copper and brass by bubbling the gas through a silica tube for twenty to thirty minutes, allowing the molten metal to rest at constant temperature for ten minutes, then teeming it into a closed crucible and aspirating the gas evolved upon solidification. The amount dissolved in copper varies with the temperature, as follows:

Saturation Temp., Deg. C.	Hydrogen Evolved on Solidification Mg. per 100 g. metal
1,100	0.60
1,150	0.725
1,200	0.85

Similar tests were made on brasses; plotting against composition, the curve has a minimum at 71 per cent copper and a maximum at 61 per cent copper, thence running off to zero at 36 per cent copper. Preliminary experiments on CO and CO_2 show about the same characteristics as were found for hydrogen.

Since soundness of castings, especially large castings, is dependent upon gas evolution during solidification, it is essential to regulate the composition of the flame, even in covered crucible melting. Phosphor-copper does not remove hydrogen—copper oxide will, but the melt in that case must be further doctored for its oxygen content.

Testing of Sands, Cores and Binders

Recognizing that the ideal test of a new product is its actual use in comparison with a satisfactory article regarded as a standard of excellence, it is also true that the personal equation and a multitude of difficultly controlled variables make it necessary for such a service test to continue for some little time. Preliminary laboratory examinations are then of value even if only to indicate whether a proposed new product has any reasonable chance of succeeding in the plant. F. L. Wolf and A. A. Grubb, of the Ohio Brass Co., have therefore devised certain tests for foundry sands, cores and binders. An ideal core, for instance, should be fairly strong while green, very strong when baked, easily destructible after use, smooth surfaced, permeable, of low gas content, work easily and pleasantly in coremakers' hands. Low-power microscopic examination will give some information to the skilled observer. Shape of grain is not so distinctive as lack of mica, feldspar, calcite, clay and loam. Grains covered with dark films may be expected to absorb an unduly large amount of binder. Screen analysis, up to 200-mesh, will also give considerable information. However, the shape of the grain will have great influence on the relative permeability of sands of similar fineness, even though the percentage of voids is little different. Permeability may be measured by placing a measured amount of sand in a 6-in. U tube. This tube is connected to a 400-c.c. water column aspirator, and the time necessary for this water column to draw a measured quantity of air through the sand gives a figure inversely proportional to the permeability. Cores may also be tested by the same aspirator. A ¾ x 3-in. core is dipped in melted paraffine, the ends cleaned and then closely fitted into a metal tube connected to the water column. Time necessary to draw a measured amount of air lengthwise through this core is taken as an inverse measure of permeability. Gas content is measured by noting the loss in weight after burning a baked core in an electric furnace at 1,400 deg. C. Linseed oil as binder ordinarily gives less than 1 per cent gas content, and the burned core will usually crumble easily between the fingers. Strength of green cores can be taken by observing its self-supported length as a cantilever. Baked cores are tested in the standard cement testing machine for tensile strength.

Reclaiming Metal From Slag and Sweepings

F. L. Wolf and G. E. Alderson described the methods used by the Ohio Brass Co. for reclaiming metals from slag and sweepings, presenting figures derived from a study of a week's operations. A quantity amounting to 8,666 lb. of "slag" (skimmings) from seventy-one tons metal melted was crushed through a 4-mesh riddle, the undersize, analyzing about 20 per cent Cu, sent to a feed bin, and the oversize, amounting to 1,967 lb., returned to stock, it being clean metal. Credited at 17c. per lb., it represented a value of $335, recovered at a cost of $15.50.

Clean-up from thirty-five molding floors amounted in a week to 21,600 lb. of sweepings, consisting of heavy metallics, spillings, cores and sand. Undersize of 40-mesh screen amounted to 14,050 lb., analyzing less than 1 per cent copper, and was wasted. Through 3-mesh on 40-mesh amounted to 3,770 lb., analyzing 25 per cent copper, and was sent to the feed bin for further concentrating. Metallics amounting to 1,296 lb. were picked from the oversize, which at 17c. per lb. was alone worth $220; recovery cost $41.

Brass-castings sweepings represented material resulting from clean-up after handling small valve and railway castings poured from seventy-one tons of metal, and amounted to 10,000 lb., consisting of light and heavy metallic particles, nails, wires, broken cores, and core sand. Its treatment is similar to that given for foundry sweepings, with the following results:

Through 10-mesh, 6,620 lb. containing less than 1 per cent Cu, to waste. Through 3-mesh on 10-mesh, 2,000 lb. containing 10 per cent Cu, to feed bin. Metal picked from oversize 440 lb. at 17c.; value $75; cost $18.

Simple screening and hand picking costing $75 has thus been able to eliminate 60 per cent of waste, very

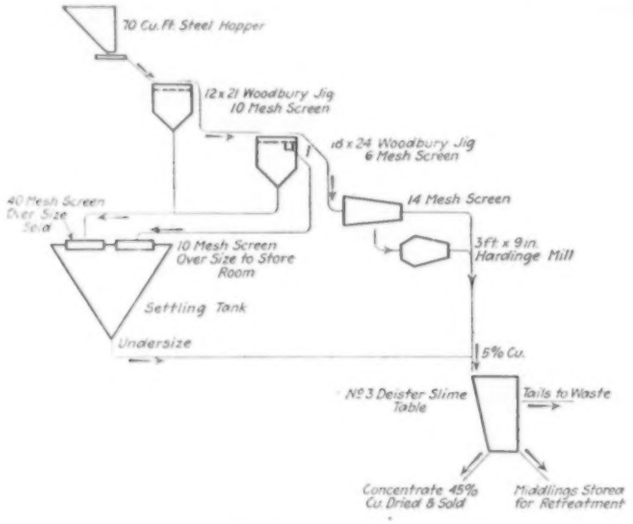


FIG. 3. FLOW SHEET OF RECLAMATION PLANT FOR BRASS FOUNDRY REFUSE

low in values—mostly metallic oxides which would need elaborate methods for recovery—with a saving of $630 worth of good metal, and 12,469 lb. of a byproduct containing 23.6 per cent copper. Almost any brass foundry should be able to go this far. Whether this byproduct should be marketed or concentrated depends largely upon the quantity being produced. At the Ohio Brass Co. it is treated according to the flow sheet, Fig. 3, in a plant costing about $6,000, with the recovery of 2,300 lb. coarse jig concentrate (metal) valued at $391, and 1,655 lb. fine concentrates, sold to a smelter for $132. Labor and power costs totaled $35 for the wet concentration only. Fig. 4 shows one corner of their clean-up department.

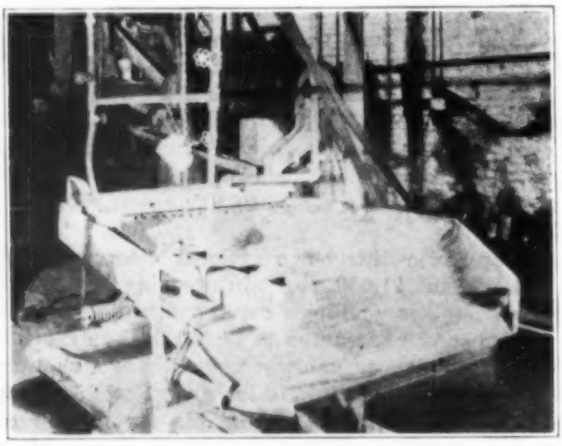


FIG. 4. CONCENTRATING TABLE MILL AND JIGS IN BACKGROUND

Relation of Die-Casting to Foundry Practice

The Relation of Die-Casting to Foundry Practice was briefly discussed by Charles Pack, of the Doehler Die-Casting Co. He noted that the use of permanent molds for lead and tin base alloys having melting points below 650 deg. F. dated centuries back. More recently low-melting alloys were produced with a zinc base. By adding aluminum and copper, lead alloys having 40,000 lb. per sq.in. were produced; elongation was controlled by adding varying amounts of tin. Upon these alloys the present die-casting industry was established. Within the last ten years aluminum: copper alloys have been successfully produced; aluminum: zinc alloys are not so satisfactory, however.

Die-casting brass is purely a problem of discovering metal for the molds. It must not scale at 1,600 to 1,800 deg. F. It must have a low coefficient of expansion and heat conductivity, together with a high elastic limit in order to withstand stresses induced by heat. Extraordinarily high strength is necessary in cores. Since it took about five years to develop a die steel which could be used for aluminum castings melting at about 1,200 deg. F., and the difficulties increase enormously with the temperature, dies for brass and bronze do not seem to be immediate possibilities. Beautiful samples can easily be made in so-called permanent molds, but Mr. Pack knew of no metal which could be used for rapid repetitive work and not produce defectives within a hundred castings. Present experience indicates that die-casting is not economical short of 5,000 pieces.

New Method for Making 15 Per Cent Phosphor Copper

A new method for making 15 per cent phosphor copper was described by P. E. Demmler. It is thought to be safer than commonly used operations where phosphorus is handled in the open, and to be less wasteful than smelting phosphate rock. If copper in the form of ¼-in. clean scrap is heated to 750 deg. F. in a closed retort into which is led phosphorus vapor, there immediately results an exothermic combination resulting in local fusion to a black, brittle mass. Equilibrium seems to be reached at 15 per cent P, even though a study of the equilibrium diagram reveals no compound of this percentage. The resulting mass can be remelted under carbon with little loss in phosphorus, and cast in ingots. Phosphorus alloys with zinc, tin and cadmium in the same manner. The same principle may also be used in making such alloys as of arsenic or selenium. Phosphor-tin is unstable on remelting if it contains more than 2 per cent phosphorus, but particles of a crude 13 per cent alloy will readily dissolve in molten tin.

Casting Losses in Aluminum Foundry Practice

Robert J. Anderson of the Bureau of Mines presented general information on Casting Losses in Aluminum Foundry Practice, gained from a questionnaire. It appeared that about 10 per cent of the castings made were rejected. On the basis of 81,000,000 lb. total output, this waste at 12½c. per lb. involves $1,125,000 money loss. Few records are available as to the cause of rejection; one large foundry reported 2.3 per cent defectives due to cores, 3.2 per cent due to molding errors, 2.6 per cent due to cracks, 2.3 per cent due to faulty pouring or run-outs, 2.4 per cent broken in handling and 1.0 per cent due to miscellaneous causes.

Refractories for Electric Furnaces

AN INTERESTING symposium on refractories for electric furnaces was held by the Electric Furnace Association in Columbus, Ohio, Wednesday, Oct. 6. Requirements for high-temperature service were first listed, and then stock was taken of our present raw materials and finished products, contrasting their good points against their shortcomings, with definite recommendations for usage apt to develop the best service. Finally an account was given of some investigative work under way from which might be expected the development of a more useful refractory for extremely high temperatures.

Superlative Requirements for Electric-Furnace Refractories

A contribution from the Foote Mineral Co. outlined the superlative requirements for electric-furnace refractories, noting first that refining furnaces, handling metal and corrosive slag at temperatures limited only by the melting point of the furnace itself, have about reached the limit of their possible development. A new, cheap, dependable refractory with a melting point higher than 1,750 deg. C. is now required, a substance which is highly resistant to sudden temperature variation so as to permit intermittent operation, which has been calcined at electric-furnace temperature and which therefore may possess reasonable constancy of volume. It must resist the scour of slag—or if a roof brick, must withstand the action of fume, hot gases and splatters of liquid. It must be a poor conductor of electricity, else leakage of current may be serious. Lastly, it must have sufficient strength at high temperatures so that arches and side walls may hold up.

Manifestly none of our present refractories possesses all these properties at once, as pointed out by several speakers, notably R. M. Howe of the Mellon Institute, H. F. Staley of the Bureau of Standards and A. F. Greaves-Walker, of the American Refractories Co. Fireclay brick are in widest use in the general metallurgical industry, and many electric-furnace sidewalls are built up with them, but unless the walls are very thin and radiate heat very rapidly, or are water cooled, the inner surfaces melt down quickly, or soften and absorb quantities of slag and metal from the bath. Silica brick, particularly from Pennsylvania and Wisconsin materials, have given best service in roof arches. Silica brick melt at about the same temperature as fireclay, but retain their shape and much of their strength to a high temperature. On the other hand, they suffer wide variation in size if not properly burned, and in any case must be heated or cooled at a low rate. Calcined dolomite, although cheap, air slakes readily, consequently its use is confined to making tamped furnace bottoms and for patching.

Magnesite brick appears to be about the best and most usable of our refractories. Mr. Walker was loud in its praises, and was sure that when the Austrian magnesite re-entered the American market in quantity, much of the present complaint against unsuitable furnace linings would vanish. While MgO is reduced by carbon at 1,800 deg. C., at lower temperatures it withstands corrosion from most melts, fireclay and water vapor being its two greatest enemies. For best results its lime content should be low, and its tendency to spall may be successfully combated by keeping moisture away and preventing strong temperature changes. High lime magnesite or magnesite with 10 to 12 per cent slag admixture is often used for basic furnace bottoms. Mr. McCoy reported a microscopic examination of such a bottom after 200 heats. While the material tamped in contained 16 per cent CaO originally, it now analyzed but 4 per cent, the remainder having been fluxed or worked out. Structurally it was a complex consisting of periclase crystals (MgO) cemented by monticellite, the calcium-magnesium ortho-silicate. Rockwell called attention to the successful use of steel-clad magnesite blocks for bottoms, and particularly in panels built in sidewalls at hot spots near electrodes. A soft-steel box of brick size, with one end missing, is rammed hard with ground dead-burned magnesite. These are not burned, but after drying are laid as headers; upon heating, the iron case melts and a "jointless" surface results which by virtue of its manufacture is more porous than the pressed burned brick, and will stand more rapid temperature changes with less danger of spalling. An instance was cited of a furnace manufacturing chromium-vanadium steel. Whereas thirty heats were the best record on a brick lining, 111 heats were procured from the tamped blocks.

Chromite brick have also been of unsatisfactory quality for many years. Local ores contain only 30 to 40 per cent Cr_2O_3 and brick made of them fail at low temperature. Meantime open-hearth furnacemen have discovered that a layer of chromite is not necessary to separate magnesite from silica brick, consequently their greatest use has been lost. The brick themselves are difficult to make on account of lack of a good bonding substance, and they have a high thermal conductivity. On account of their resistance to either acid or basic baths, however, good chromite brick might be utilized for several courses in sidewalls, near the slag line.

Bauxite is favored as a lining for the hot zones of cement kilns. Other metallurgical uses have not been so successful. As a brick it is difficult to make because of the lack of a desirable binder; it shrinks continuously under heating unless the raw material has been calcined and the brick burned at the most extreme temperatures. After such treatment successful basic bottoms of bauxite have been reported analyzing as high as 15 per cent SiO_2, although 5 per cent would have been a much safer figure. Even fused alumina brick cannot be used in furnace roofs, since they react readily with lime vapors.

This list about exhausts the common refractories now on the market, firebrick which have been in use long enough and in such quantity as to be out of the experimental stage. Alundum and carborundum have been under examination as furnace refractories for some time. Despite their cost, their use may easily prove economical; particularly has this been demonstrated when used as door jambs. Carbon, either amorphous or graphitized, also has special applications in furnace bottoms.

Carborundum as a Refractory

Carborundum as a refractory was discussed at length by Dr. M. L. Hartman, in two papers—one at this meeting and the other read before the Foundrymen's convention. Four types are now on the market: (*a*) Recrystallized carborundum, which are shapes passed through the electric furnace the second time, the bond consisting of intergrown crystals; (*b*) three kinds of bonded carborundum, shapes composed of small crystals bonded with certain refractory mixtures; (*c*) various cements for molding shapes directly in furnaces and for

patching, consisting of carborundum with different bonding materials; and (*d*) firesand, a furnace byproduct consisting principally of silicon carbide and partially reduced oxycarbides, suitable for rammed-up linings.

From these products a wide variation in refractories can be obtained. In general, however, while carborundum has a very high decomposition temperature, it begins to dissociate appreciably under oxidizing conditions at about 1,500 deg. C., and under reducing conditions at 1,700 deg. C. Lead oxide reacts with silicon carbide very rapidly. Iron, steels and their ordinary slags also decompose carborundum. It has no softening or transition temperature short of decomposition; its thermal conductivity is high, its coefficient of expansion is low, it resists non-ferrous metals except lead, and it is extremely hard and durable. A bonded variety is made with good electric resistivity at high temperatures.

Detailed applications are cited. The Baily furnace may have the trough containing the carbon resistor molded of firesand, which has a high electrical resistance, is refractory, and is unaffected by carbon and CO. In the General Electric contact arc furnace, the walls may be of carborundum shapes, highly refractory and with a low coefficient of expansion, thus avoiding metal leakage. Arc furnaces in ferrous service may have roofs of carborundum held very close to the bath, which is desirable, but only if the electrodes enter through insulating sleeves. In non-ferrous practice, the rotative furnaces are popular, heating the metal largely from the lining, which of course must withstand the mechanical wear. To reduce the extreme first cost, an effort is being made to develop a composite lining, consisting of a thin inner coat of carborundum, a stout backing of cheaper refractory, and an outer sheath of insulator. As a matter of fact, the discovery of a really good insulator which stands up and still insulates when heated to a high temperature would cause a revolution in the use of refractories. At present low-melting brick are purposely cooled, wasting enormous quantities of heat in order to maintain the furnace structure. With an efficient insulator a thin lining of some really heat-resistant material could be used, whose present use to build walls is prevented on account of its high cost.

New and Better Refractories

After this discussion of the natural and artificial refractories which are now available in quantity, Mr. Stull, of the Columbus station, Bureau of Mines, together with H. F. Staley, of the Bureau of Standards, pointed out the direction from which new and better refractories might be expected. A study of the SiO_2 : Al_2O_3 equilibrium diagram revealed one compound, sillimanite, with a melting temperature about 1,820 deg. C. This mineral is not available in commercial amounts, but a synthetic product of this composition has been made and used. For instance, Mr. Berry noted that aluminous brick containing high silica had proved very good for rocking brass furnaces. Commercially it is manufactured by mixing proper proportions of fireclay and bauxite, grinding, and calcining at 2,700 to 2,800 deg. F. in a fuel-fired kiln. The resulting clinker is then crushed, bonded with a little of the original slurry, slop molded, repressed, dried, and burned at the maximum temperature possible in the ordinary kiln (2,800 deg. F.—far below the melting point of sillimanite).

A similar compound, spinel ($MgO.Al_2O_3$), occurs in that system, melting at about 2,130 deg. C. Like sillimanite, it should remain rigid nearly up to its melting point—melting at a fixed temperature, and not, like a fireclay, through a temperature range. Spinel brick have double the life of magnesite when used as charging doorsills, and should be no more expensive in first cost.

Zirkite brick, made from calcined zirconium carbonate, are also in experimental use. Unfortunately the commercial carbonate usually is high in silica. Zirconia also reacts easily, forming carbides at high temperatures. The last fault does not apply to zircon brick, made of the mineral $ZrO_2.SiO_2$. This compound melts at about 2,560 deg. C., but it is very difficult to make brick with a satisfactory bond. Aluminous binders especially must be avoided. Ground ore is the best agent, but this requires a burning temperature far above the possibilities of any but an electric furnace. Even here the difficulties in getting a uniform high temperature throughout a large volume are obvious and almost insurmountable.

Fused zircon, according to Staley, has permanent volume. It is an acid refractory, being attacked by basic slags and hydrofluoric acid, but not by molten silica. It has a low coefficient of thermal expansion, but at the same time a low thermal conductivity; consequently it is liable to check badly on sudden temperature changes. It has a high electrical resistance. All in all, and especially in view of the occurrence of the mineral zircon in quantity, this refractory presents the best chances for immediate improvement for acid linings.

A Rapid Qualitative Method for Nickel in Steel

By Melvin B. Danheiser*

The method here described was developed as a reliable method for separating nickel steel from other steel without cutting samples for a regular chemical test. In many cases this test can be used on finished steel parts without destroying the piece. The complete test can be made in three to five minutes.

A few filings (about the amount that can be heaped on the head of a pin) are placed upon a watch glass 1½ in. in diameter. A drop of nitric acid sp.gr. 1.42 is added from the end of a glass rod. If action does not start immediately, warm slightly. Allow to effervesce for one-half minute. Add a drop at a time of the ammonia-dimethylglyoxime reagent until action ceases and the solution becomes pink. Allow to stand one minute, place under microscope using a 16 mm. objective and examine for crystals of nickel dimethylglyoxime, which occur as pink needles but when massed have the appearance of a pink pulp.

With a steel containing no nickel a pink or red solution is formed which turns brown on standing. No crystals occur until the solution has evaporated almost to dryness and then they are brown and distinctly different from the nickel dimethylglyoxime crystals.

In order to become familiar with this test a small crystal of a nickel salt is put through the same procedure as the steel and the crystals formed compared with the steel under test.

The ammonia-dimethylglyoxime reagent is made as follows: 5 g. of citric acid is dissolved in 90 c.c. of 1:1 ammonium hydroxide sp.gr. 0.90 and 10 c.c. of a 1 per cent solution of dimethylglyoxime in alcohol added.

*Metallurgist, Imperial Drop Forge Co., Indianapolis, Ind.

Varnish Fume Recovery

New Methods of Recovering Fume From Three Stages of Varnish Manufacture — Description of Plant at the Arco Co.—Other Installations—Experimental and Operating Data—Chemistry of Gum Distillation—Possible Future for Recovery Products

By CHESTER H. JONES

As so often occurs in other industries, the necessity for the protection of the workmen and the neighborhood from objectionable fumes developed in the manufacture of varnish has resulted in an economy for this industry which will go far toward putting it on a scientific basis. It has only been a question of months since the making of varnish in all factories was simply a cooking operation similar to a high-class bakery or ordinary vegetable cannery. The gums were dumped into open copper or iron kettles in proportions dictated by secret "deathbed formulas" and cooked over a coke fire to a point where the "expert" varnish maker determined the batch to be finished. No chemical control was used, and as there was little to keep secret, deep secrecy was therefore maintained.

The fumes from the kettles, mingled with those from the fire, sometimes passed up the stacks—especially when the wind was right—as the builder hoped they would, and were dissipated in the form of a disagreeable "foreign" odor over the surrounding countryside. Fig. 1 shows an installation of this type so common today.

At the conclusion of the cooking the kettles were drawn to the cooling shed, thence to the reducer room, where certain thinners such as light oils and turpentines were poured into the warm mass. This was an occasion of more fumes, obnoxious to the workmen and incidentally a direct loss of the volatile thinner liquids to the manufacturer.

The foregoing paragraphs should be written in the present tense to be strictly accurate, for the description covers the operations in most plants today. The old-time stack process will, however, soon be superseded in progressive plants.

At any rate, the method continued in general use until the officials of a hospital in Providence, R. I., began to complain of the fumes from the plant of the U. S. Gutta Percha Paint Co., and after considerable study on the part of the technical staff the first modern recovery plant was installed there in January, 1918. Since that time the engineers, Perry & Webster, Inc., have issued licenses to sixteen different varnish makers either for the new type stackless plant or for installations in old-type stack plants, for the purpose of recovering values from the fumes developed in both the cooking and thinning operations.

Like most chemical engineering work, the new method comprises the simple application of well-known mechanical principles to existing chemical processes. One of the more recent installations is just going into operation at the plant of the Arco Co., Cleveland, Ohio, and is therefore most suitable for a detailed description of the method.

The Arco Co.

This organization is an excellent example of the progressive type of paint and varnish manufacturer, as evidenced by the employment over a number of years of a physical, chemical and japan testing laboratory in control of the plant operations and in research for better methods. Fig. 3 shows a section of the chemical laboratory. All raw materials are analyzed and samples from each batch of finished varnish are held for two years against complaint from the consumer. The laboratory work is divided into four departments—namely, house paint and enamels, machinery finishes, automobile color and varnish and finishes, and japanning and baking enamels.

Tests are made both at the finish of the batch and after thirty days' standing. If trouble is encountered, the goods are returned, but if laboratory tests prove satisfactory, trouble men are sent out to help the consumer.

Naturally a company pursuing such policies would be among the first to adopt the new recovery methods.

Varnish Recovery Plant

Fig. 2 is the building at the Arco plant housing the new sixteen-fire, two-story stackless varnish process. It is designed for future extension to forty-eight-fire capacity. Note the basement entrance in the foreground arranged for trackage to remove ashes. The ashpits are all below the operating floor and are so arranged that gas or oil firing may be substituted for the coke grates at any future time. The large stack has no connection with the process. The two steel stacks at the end of the building lead from the exhausters which create the positive draft on the coke fire. The door on the side of the building at the extreme left opens into the elevator shaft through which raw materials are lifted to the second floor, daily storage, shown in Fig. 4.

Here the solid materials are stacked in concrete compartments, while the various oils are pumped to tanks directly above. In charging, the gums are shoveled into the hoppers appearing in the center on the floor and the oils are emptied through a battery of pipes terminating near a Kron platform scale in the operating room.

Fig. 5 shows the melting or operating floor, with eight fires on each side. The pair of overhead rails carry a traveling weighing hopper which is filled with the gums through the spouts leading from the hoppers above described and empties directly into the cooking kettles conveyed on trucks beneath. When a kettle is charged with gums it is wheeled onto the platform scale to receive the necessary charge of oils. The traveling hopper may also be moved into the cooling and thinner rooms on the overhead rails.

The two Buffalo Forge Co. planing mill exhausters for the fire combustion smoke appear on the balcony at the extreme end of the room. (Exhauster stacks shown outside in Fig. 3.) The positive suction over each fire insures sufficient draft to secure nearly perfect

combustion with a scarcely noticeable smoke issuing from the stacks. These exhausters have no connection with the fume-recovery system.

Cooking Operation

The charged kettle is placed over the fire and fume exhaust cover is lowered as shown in Fig. 5. These covers are shown raised in the left hand bank. The lids are attached to a collapsible swinging pipe which is easily manipulated by hand. Tycos thermometers attached to long pipes are thrust through the kettle door into the mass as shown in the hand of the operator to the left in Fig. 5.

The cooking time required about an hour and a half under the old system, but thirty minutes is sufficient with the new arrangement. The temperature varies with the formula of the mix, but the maximum requirement is about 750 deg. F. (399 deg. C.). The lid and exhaust system minimizes the possibility of a batch flashing or burning as under the old method. Screens are inserted in the flues to localize spontaneous combustion. Before passing on to the fume recovery system compare the operating floor with the old method shown in Fig. 1 as carried on in the same factory.

Cooling the Batch

Because of the high temperature of the melt when removed from the fire it is not possible to add the volatile thinners until the batch has been considerably cooled. The kettles are therefore drawn to the cooling room on the same floor and placed beneath lids with flues connecting to the same fume exhaust recovery system as operates in the cooking process. A corner of the cooling room appears in Fig. 6. Here the electric switches are also located and from this point the operator may control any motor in the plant, including those in the third floor penthouse.

Varnish Fume Recovery

The fumes from the two sources mentioned above are drawn through a water-scrubbing tank located in the penthouse where the heavy particles settle out and the remainder passes through the turbine, Spencer Turbine Cleaner Co., to a similar tank filled with lime water, where the finer particles are precipitated. The apparatus for one bank of eight fires is shown in the foreground of Fig. 7.

There are three points of recovery from the fume system. First, the product which condenses on the inner surfaces of the piping ahead of the water tank and which is piped back to the kettles from convenient points in the line; second, the condensate caught in the water-scrubbing tank which settles to the bottom and is drawn off to be eventually returned to the kettles; and third, the product of the lime water-scrubbing tank, a sort of lime soap or emulsion, which is boiled to remove the excess lime water and neutralized with acid before returning to the kettles.

The amount of fume which is finally released to the atmosphere is so small as to be scarcely discernible to the eye and has only a slight soapy odor. The vacuum maintained on the kettles is just sufficient to carry off the fume and give a minimum amount of work to the scrubbing tanks.

The thinner recovery system operates entirely separate from the combusion or fume recovery system. When the kettles are sufficiently cooled but still warm they are wheeled to the thinner room, a section of which appears in Fig. 8, and placed beneath the movable lids. The oils or thinners are added to produce a varnish of the desired consistency. These thinners are so volatile it is necessary to maintain a suction on the line during the operation to carry the fumes into the flues, where they are condensed in the cleverly constructed piping system, the condensate flowing back to the kettles. A Buffalo Forge Co. planing mill exhauster is installed on the roof to produce the required vacuum and the air, containing less than 2 per cent of the total volatiles used, is carried directly to the atmosphere. It is reported by one manufacturer that whereas 8 per cent of the total thinners employed were previously lost 6 per cent of the total is now recovered, giving a net loss of only 2 per cent.

Clarifying for the Market

While this completes the description of the new process at the Arco plant, it seems pertinent to mention the method of finishing the product for the market. The varnish is pumped from the kettles in the thinner room to large settling tanks, thence through a centrifugal separator of the DeLaval type to the final storage. The centrifugal method of clarifying as shown in Fig 9 is thought much superior to other means involving filtration. Fig. 10 shows a battery of tanks containing separate manufacturing lots ready for the market.

Other Installations

Before taking up the economies effected through this system it may be helpful to show two other installations. The Patterson-Sargent Co., of Long Island City, N. Y., installed a six-fire unit several months ago. It has operated successfully from the start. Fig. 11 shows the building, with penthouse on top and condenser pipes on the outside. The large stack has no connection with the varnish recovery. The elbow pipe on top of the penthouse carries the final exhaust from the varnish kettles and the square stack emits the combustion gases. Room has been provided for installing an additional unit of six fires. Connersville blowers were used on the fume system.

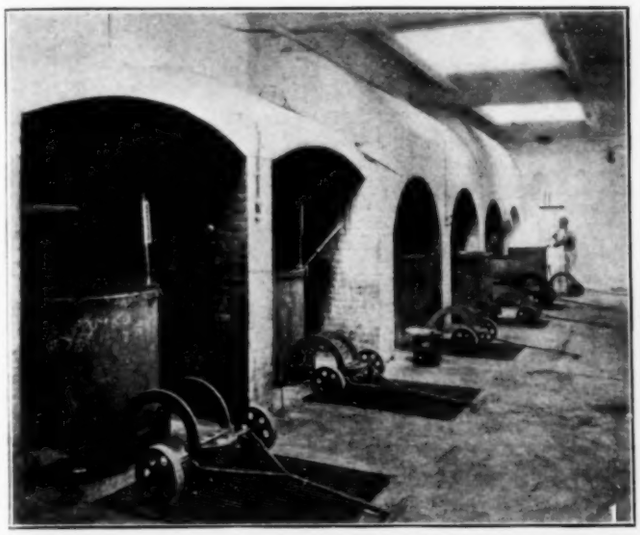
Fig. 12 shows the fires in the melting room, and the cooling apparatus is seen through the doorway on the left. Fig. 13 also shows the cooling room and storage with provision for additional units. The building was planned to house an old-type stack plant, but during the process of erection was changed to accommodate the new fume recovery system. This accounts for the unnecessary amount of overhead space in the cooling room.

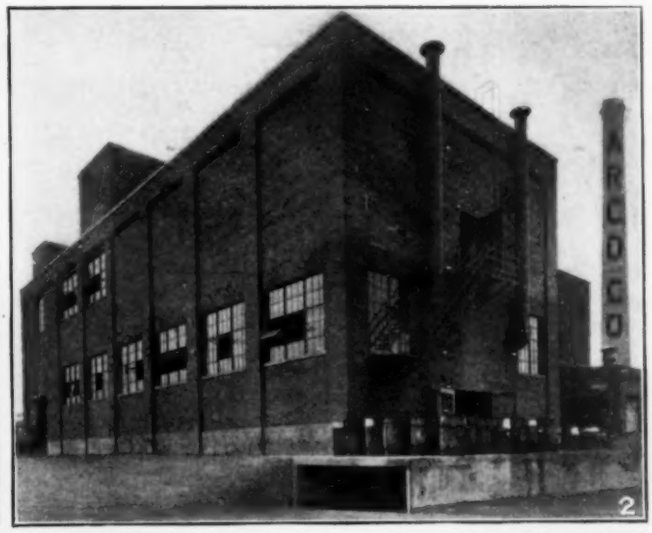
Fig. 14 is one of the fires in the original installation at Providence, R. I., where a stack plant was changed to accommodate the stackless system. Roots blowers were installed on the exhaust line.

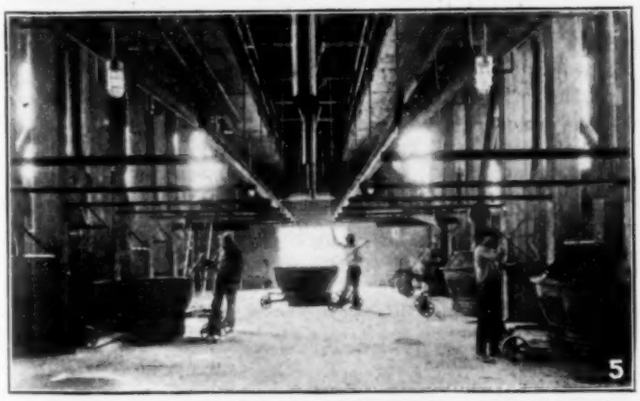
One of the latest design two-story plants just being erected in the West is shown in plan and section, Figs. 15 and 16. Out of sixteen plants only two have been installed for the primary purpose of eradicating the nuisance to the neighborhood arising from the escaping fume; the benefits of recovery of fume value, fire prevention, increased efficiency and lessened cost of operation were inducements in the other instances.

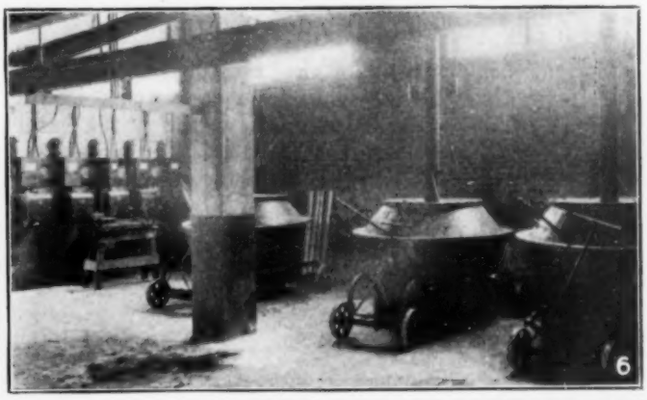
Cooking Losses in Stack Plants

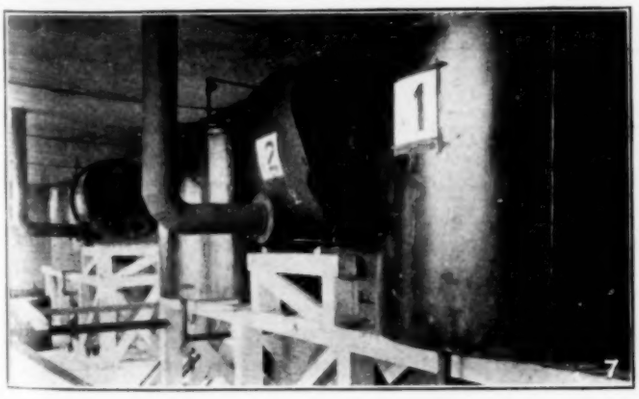
While operating losses are somewhat hard to determine accurately on a weight basis due to the fact that the blend or mix consists of several gums of varying specific gravities and values and to the fact that there are gains in weight through chemical reactions such as











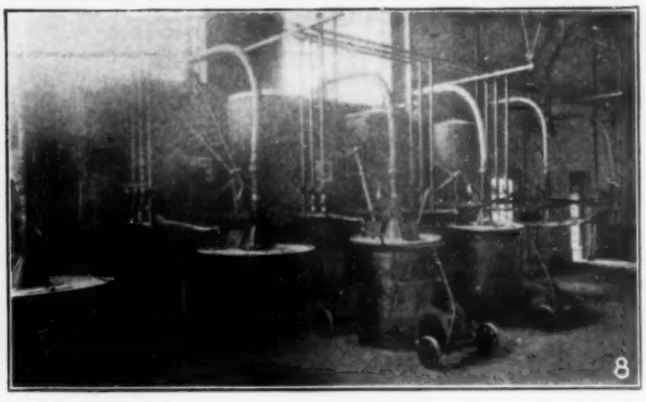
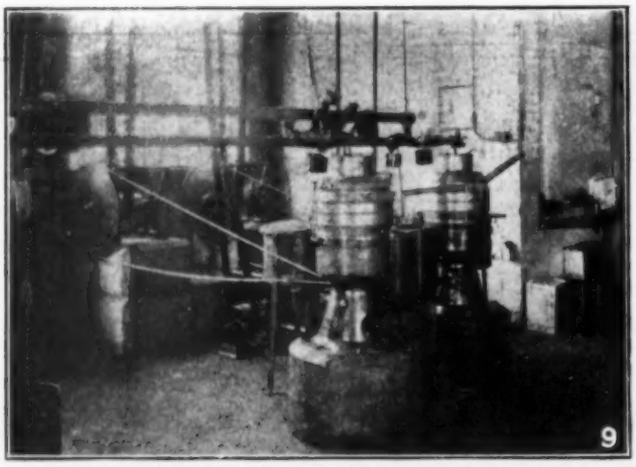
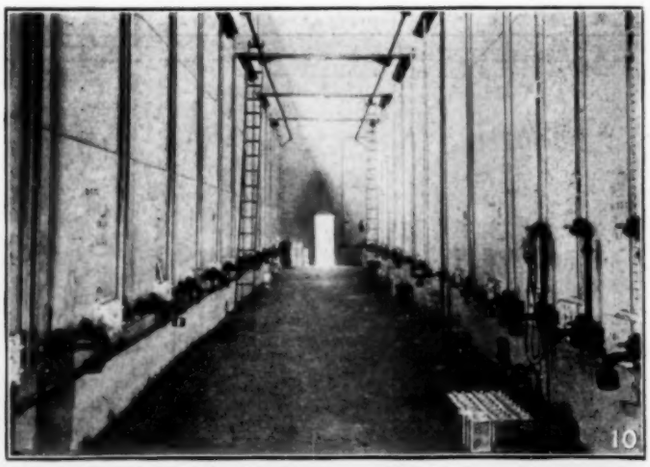
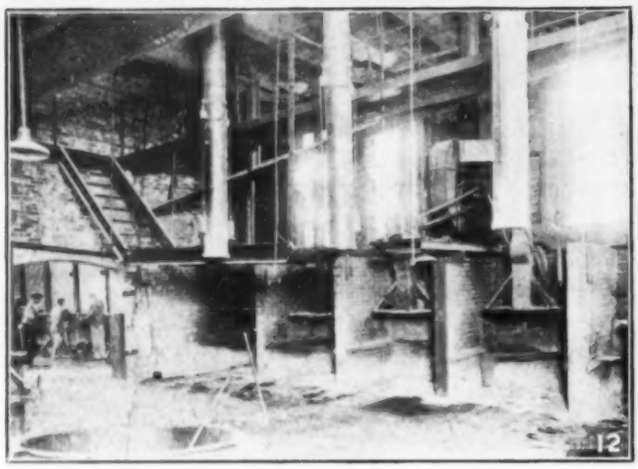


Fig. 1. Common type of varnish-making installation.
Fig. 2. Arco Company plant.
Fig. 3. Section of chemical laboratory.
Fig. 4. Storage room.
Fig. 5. Melting or operating floor.
Fig. 6. Cooling room.
Fig. 7. Varnish fume-recovery apparatus.
Fig. 8. Thinner recovery apparatus.







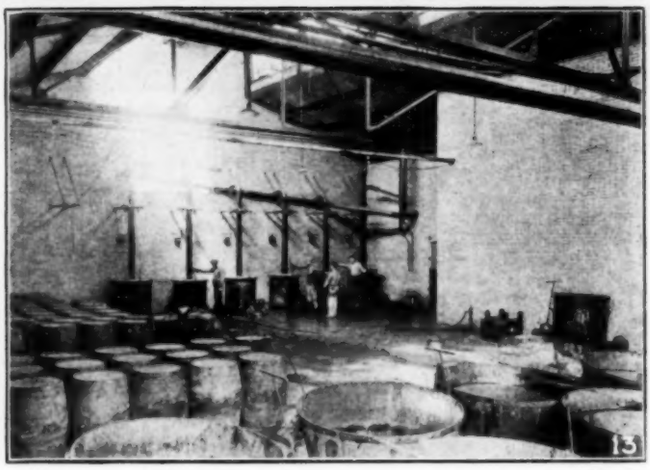


Fig. 9. Centrifugal clarifiers.
Fig. 12. Melting room.

Fig. 10. Storage tanks for finished products.
Fig. 13. Cooling room and storage.

oxidation, considerable data have been prepared by several operators. The following from Circular 96 issued by the educational bureau, scientific section of the Paint Manufacturers' Association of the U. S., in co-operation with the National Varnish Manufacturers' Association, shows that the over-all loss runs from 12 to 20 per cent and the actual gum loss may run from 30 to 42 per cent of the amount used in the varnish.

The figures are all on losses shown by varnish bases previous to reducing by turpentine or other thinners.

FIG. 11. THE PATTERSON-SARGENT PLANT

GUM LOSS IN KETTLE

	Overall Loss by Weight, per Cent	Loss of Gum Used by Weight, per Cent
Long Oil Kauri Varnish	12.4	30
Short Oil Kauri Varnish	20.0	34
Long Oil Manila Varnish	16.0	40
Short Oil Manila Varnish	20.0	42

PROPORTION BY WEIGHT OF OIL AND OF GUM IN FUME

	Oil, per Cent	Gum, per Cent
Long Oil Kauri Varnish	33⅓	66⅔
Short Oil Kauri Varnish	11.5	88.5
Long Oil Manila Varnish	27.3	72.7
Short Oil Manila Varnish	12.5	87.5

This latter table shows that the gum loss is greater in weight. If the cash value is considered the proportionate loss is even greater, as follows:

FUME LOSS PROPORTIONS IN MONEY VALUE

	Oil, per Cent	Gum, per Cent
Long Oil Kauri Varnish	15	85
Short Oil Kauri Varnish	5.4	94.6
Long Oil Manila Varnish	24.7	75.3
Short Oil Manila Varnish	11.0	89.0

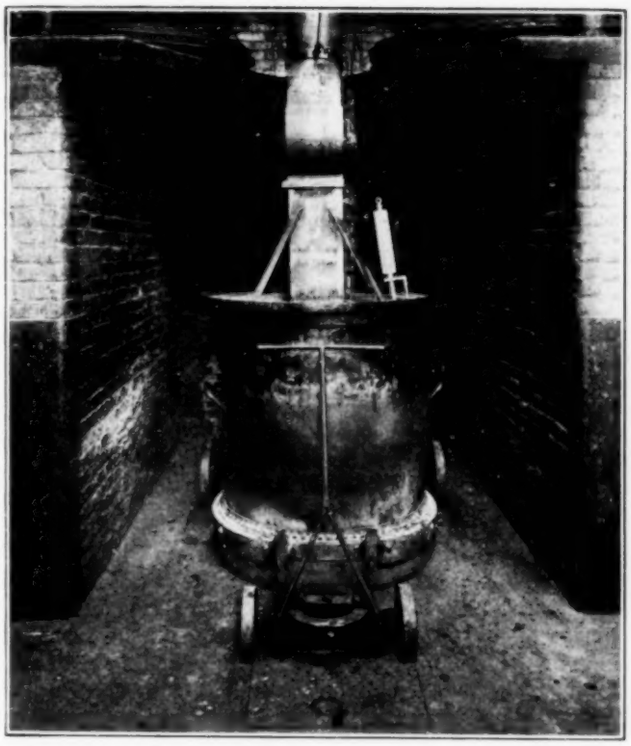


FIG. 14. ONE OF THE FIRES IN THE ORIGINAL INSTALLATION AT PROVIDENCE, R. I.

Further tests made on losses in cooking oils alone, given in Bulletin 95 issued by the Educational Committee are also of interest.

	Sp.Gr.	Percentage Weight Loss	Percentage Volume Loss
Raw Linseed Oil:			
500 deg. F. (260 deg. C.), for 4 hr	0.9477	2.90	4.46
550 deg. F. (290 deg. C.), for 4 hr	0.9690	8.60	12.05
Varnish Makers' Linseed Oil:			
500 deg. F. (260 deg. C.), for 4 hr	0.9482	2.20	3.88
550 deg. F. (290 deg. C.), for 4 hr	0.9666	5.40	8.79
Fish Oil (Menhaden):			
500 deg. F. (260 deg. C.), for 4 hr	0.9671	5.16	8.45
550 deg. F. (290 deg. C.), for 4 hr	0.9800	9.16	13.47
Soy Bean Oil:			
500 deg. F. (260 deg. C.), for 4 hr	0.9391	4.52	5.80
550 deg. F. (290 deg. C.), for 4 hr	0.9498	8.57	10.81
Oriental Perilla Oil:			
500 deg. F. (260 deg. C.), for 4 hr	0.9560	4.79	6.79
550 deg. F. (290 deg. C.), for 4 hr	0.9800	8.73	12.83
Sunflower Seed Oil:			
500 deg. F. (260 deg. C.), for 4 hr	0.9345	4.04	5.12
550 deg. F. (290 deg. C.), for 4 hr	0.9430	9.33	11.16

In his bulletin "Fume Control in the Varnish Industry," Henry A. Gardner says: "The equivalent of a varnish kettle running continuously on one of these type varnishes would thus indicate a yearly fume loss on gum and oil equivalent in money to the cost of the products lost. It should, however, be pointed out that even entire recovery of fumes would not necessarily mean recovery of the original value of the products from which they were derived. This is due to the fact that oil and gum fumes recovered as condensates by any system are of different composition than the materials of their origin and of much less money value. Nevertheless, the data show the importance of fume recovery; and it is quite possible that certain products might be fractionated from condensed gum fumes that would have an even greater money value than the original gums."

Those who have witnessed the new plants in operation are strongly impressed with the facts that a negligible amount of fume is released to the atmosphere, that a large amount of material is directly recovered as primary condensate and that there is unlimited scope for development by research of the products taken in the water and alkali scrubbers. Manufacturers using the new plant are enthusiastic over this last point.

Considerable importance is given in Mr. Gardner's bulletin to the work done by Smith and dePierres as presented before the Eighth International Congress of Applied Chemistry as to autoclave determinations of varnish materials.

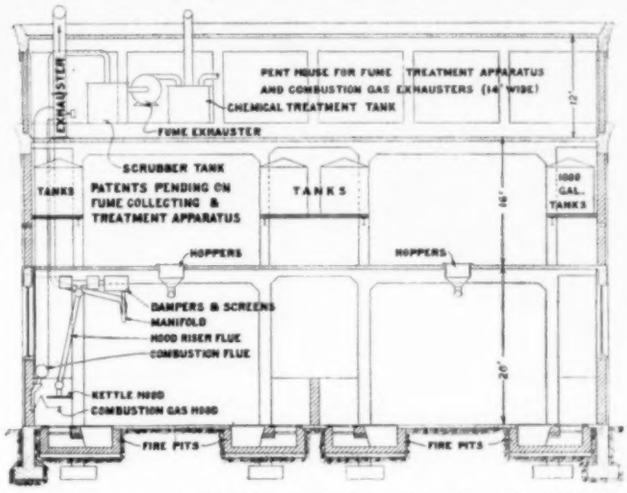


FIG. 16. CROSS-SECTION 2-STORY, 24-FIRE, STACKLESS VARNISH PLANT

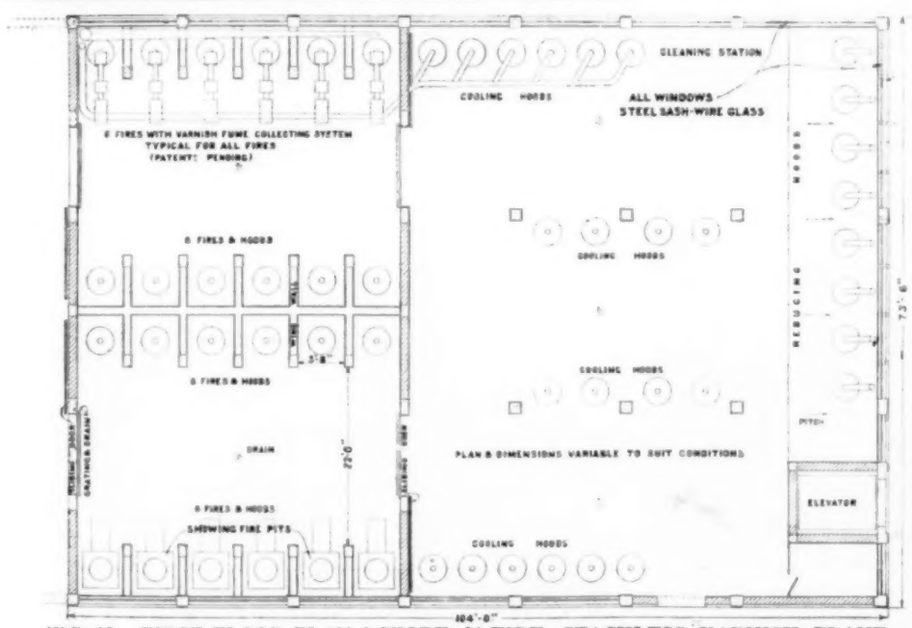


FIG. 15. FIRST FLOOR PLAN 2-STORY, 24-FIRE, STACKLESS VARNISH PLANT

Recent Data From Actual Plant Operation

The following fume loss data and calculations taken from a manufacturer's factory records on four typical high-grade batches under good practice with kettles covered while melting the gum and open during the cook-out and finishing, while unconfirmed by the writer, may be considered authentic. It is necessary only to figure the materials at present market conditions to see the large saving effected through fume recovery.

SHORT OIL MANILA VARNISH

Type, 10 gal. oil to 100 lb. gum

Actual formula:

Kettle Charge:	Lb.
Hard white manila	190.00
W.W.	10.00
Drier salts	6.00
Treated oil (20 gal.)	155.00
Total kettle charge	361.00
Thinner turps (5 gal.)	35.00
Texaco (55 gal.)	357.50
Total formula	753.50
Oil, loss prior treatment	12.00
Total materials used	765.50
Total yield of varnish	636.40
Loss, 20 per cent	129.10

Distribution of Above Loss

	Lb.	
Oil loss:		
On previous oil treatment (8 per cent of bulk)	12.00	
Drier loss (figured at 50 per cent):		
Including loss of drier in oil treatment	6.00	
Thinner losses:		
Turps and Texaco 6.85 per cent of amount used	27.00	
Total		45.00
Gum losses (by difference):		
42 per cent of original weight of gum used		84.10

LONG OIL MANILA VARNISH

Type, 25 gal. oil to 100 lb. gum

Actual formula:

Kettle charge:	Lb.
Hard white manila	200.00
Treated oil (50 gal.)	387.50
Total kettle charge	587.50
Thinners:	
Turps (5 gal.)	35.00
Texaco (55 gal.)	357.50
Total thinner used	392.50
Total formula	980.00
Oil loss on prior treatment	30.00
Total materials used	1,010.00
Total yield of varnish	870.00
Loss, 16 per cent	140.00

Distribution of Above Loss

	Lb.	
Oil loss:		
On previous oil treatment (8 per cent of bulk)	30.00	
Drier loss (at 50 per cent):		
Including loss of drier in oil treatment	3.00	
Thinner losses:		
Turps and Texaco at 7 per cent of amount used	27.50	
		60.50
Gum losses (by difference):		
40 per cent of original weight of gum used		79.50

SHORT OIL KAURI VARNISH

Type, 8 gal. oil to 100 lb. gum

Actual formula:

Kettle charge:	Lb.
Ex. No. 1 Kauri	200.00
Treated oil (16 gal.)	124.00
Drying salts	10.00
Total kettle charge	334.00
Thinners:	
Turps (50 gal.)	350.00
Total formula	684.00
Oil loss on prior treatment	8.85
Total materials used	692.85
Total yield of varnish:	
78 gal. at 7½ lb.	585.00
Loss, 20 per cent	107.85

Distribution of Above Loss

	Lb.	
Oil loss:		
On previous oil treatment (8 per cent of bulk):		
Volume loss 1.18 gal. at 7.75 lb.	8.85	
Drier loss (at 50 per cent):		
Including loss of drier in oil treatment	7.00	
Thinner losses:		
Turps at 6.8 per cent of amount used	24.00	
		39.85
Gum losses (by difference):		
34 per cent of original weight of gum used		68.00

LONG OIL KAURI VARNISH

Type, 25 gal. oil to 100 lb. gum

Actual formula:

Kettle charge:	Lb.
XX Kauri	200.00
Oil not treated (50 gal.)	387.50
Drier salts	4.5
Total kettle charge	592.0
Thinners:	
Turps (50 gal.)	350
Total formula	942
Yield	825
Loss, 12.4 per cent	117

Distribution of Above Loss

	Lb.	
Oil loss (8 per cent of bulk)	30.00	
Drier loss (at 50 per cent)	2.25	
Thinner losses:		
Turps at 7 per cent of amount used	24.50	56.75
Gum loss (by difference):		
30 per cent of original weight of gum purchased		60.00

The oil measured and weighed cold at the start 100 gal. and 750 lb. and at the finish 92.6 gal. and 717.65 lb., giving a volume loss of 8 per cent. Previously treated linseed oil was used in all cases excepting the Long Oil Kauri Varnish in the last batch, on which, being taken without previous treatment, all shrinkage occurred in the kettle. Where the oil had been previously treated the shrinkage on factory practice was 8 per cent by volume and the weight per gallon increased from 7½ lb. for the untreated to 7.75 per gal. for the treated oil.

Drier losses are calculated on basis of one-half of all drier salts dropped out or left in filters from batch and also from drier used in oil treatment.

Conclusion

The new stackless system then is the practical application of theories long extant. Its mechanical features are such as to secure the desired recovery without radical departure from habits of previous operations. A development at once extremely beneficial in its chemical accomplishments and conservative in its mechanical features should be especially valuable for installation in the plants of going concerns. As each new industry is added to the growing list of those which have entered upon the era where economies are effected through technological considerations, where progress is speeded up through scientific control and research, there comes an increased inspiration to technical men in every line carrying them forward toward the vision where science and craftsmanship merge into art.

In conclusion the author wishes to acknowledge the courteous co-operation of Perry & Webster, Inc., and officials of the Arco Co. and the Patterson-Sargent Co. in supplying information and opening their plants to inspection.

America's Tobacco Industry

In the production of tobacco, the United States leads all other nations, the annual quantity being estimated by the Department of Agriculture at 1,000,000,000 lb. British India is second with about 450,000,000 lb. Before the war, Russia was third with 177,000,000 lb., the Dutch East Indies fourth with 163,000,000 lb., and Austria-Hungary fifth with 158,000,000 lb.

Figures for the United States production in 1919 are given as 1,389,000,000 lb., which at the present time represents more than half of the world's production.

Likewise, the United States is the biggest exporter of tobacco, having sent abroad 765,000,000 lb. in 1919.

Metallography of Arc-Fused Steel*

Various Lines of Investigation Are Utilized to Support the Idea That Microscopic "Plates" Existing in Fusion Welds Are Due to Nitrogen; That the Plates Are Very Persistent, and Are Not Responsible for the Low Ductility of the Metallic Piece

By HENRY S. RAWDON, EDWARD C. GROESBECK and LOUIS JORDAN†

AN ARTICLE entitled "The Physical Properties of Arc-Fused Steel," published in CHEMICAL & METALLURGICAL ENGINEERING for Oct. 6, 1920 (vol. 23, p. 675) described the methods used in building up blocks of arc-fused metal of size large enough to furnish a tension specimen. Fusion welds evidently are fundamentally different from other types of joints in that the metal at the weld is essentially a casting. A preliminary study of a considerable number of specimens welded under different conditions confirmed the impression that the arc-fusion weld has characteristics quite different from other fusion welds.

In the present study, of which both the former contribution and the present form a part, two types of electrodes, a "pure" iron called "A" and a mild steel called "B," were used, in the bare condition, and also after receiving a slight coating. With these were included a set of similar specimens prepared outside of the Bureau by expert welding operators. During the fusion the composition of the metal of the two types of electrodes is changed considerably by the "burning-out" of the carbon and other elements, the two becoming very much alike in composition. A very considerable increase in the nitrogen content occurs at the same time, as shown by chemical analysis.

The mechanical properties of the arc-fused metal as measured by the tension test are essentially those of an inferior casting. The most striking feature is the low ductility of the metal. All of the specimens showed evidence of unsoundness in their structure, tiny inclosed cavities, oxide inclusions, lack of intimate union, etc. These features of unsoundness are, seemingly, a necessary consequence of the method of fusion as now practiced. They determine almost entirely the mechanical properties of the arc-fused metal. The observed elongation of the specimen under tension is due to the combined action of the numerous unsound spots rather than to the ductility of the metal. That the metal is inherently ductile, however, will be shown by the changes in the microstructure produced by cold-bending. By taking extreme precautions during the fusion, a great deal of the unsoundness may be avoided and the mechanical properties of the metal be considerably improved. The specimens described, however, are more representative of actual present practice in welding.

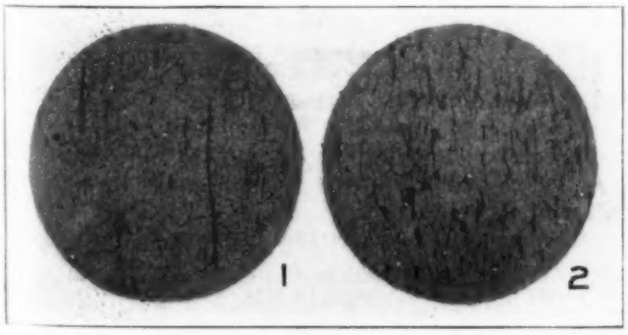


FIG. 1. "A" electrode, $\frac{1}{2}$-in. diameter. Annealed as received.

FIG. 2. "B" electrode, $\frac{1}{2}$-in. diameter. Cold-drawn.

Both × 100. Picric acid etching.

General Features of Microstructure

For purposes of comparison the microstructure of the electrodes before fusion is shown in Figs. 1 and 2. The "A" electrodes have the appearance of steel of a very low carbon content; in some cases they were in the cold-rolled state; all showed a considerable number of inclusions. The "B" electrodes have the structure of a mild steel and are much freer from inclusions than are those of the other type. It is undoubtedly true, however, that the condition of the arc-fused metal with respect to the number of inclusions is a result of the fusion rather than of the initial state of the metal.

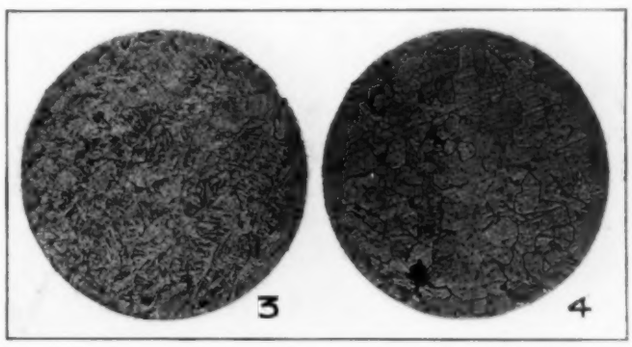


FIG. 3. Columnar structure of B_2. × 66. Five per cent picric acid etching.

FIG. 4. Equi-axed structure of $A1_2$. × 200. Two per cent alcoholic HNO_3 etching.

It is to be expected that the microstructure of the material afer fusion will be very considerably changed, since the metal is then essentially the same as a casting. It has some features, however, which are not to be found in steel as ordinarily cast. The general type of microstructure was found to vary in the different specimens and to range from a condition which will be designated as "columnar" (Fig. 3) to that of a uniform fine equi-axed crystalline arrangement (Fig. 4). This observation held true for both types of electrodes, whether bare or covered. In the examination of cross-sections of the blocks of arc-fused metal, it was noticed that the equi-axed type of structure is prevalent throughout the interior of the piece and the columnar is to be found generally nearer the surface—i.e., i-

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†Physicist, Physical Chemist and Associate Chemist, respectively, Bureau of Standards.

the metal deposited last. It may be inferred from this that the metal of the layers which were deposited during the early part of the preparation of the specimen is refined considerably by the successive heatings to which it is subjected as additional layers of metal are deposited. The general type of structure of the tension bars cut from the blocks of arc-fused metal will vary considerably according to the amount of refining which has taken place as well as the relative position of the tension specimen within the block. In addition it was noticed that the columnar and coarse equi-axed crystalline condition appears to predominate with fusion at high-current densities.

Microscopic Evidence of Unsoundness

In all of the specimens of arc-fused metal examined microscopically there appear to be numerous tiny globules of oxide as shown in Figs. 3 to 12. A magnification of 500 diameters is usually necessary to show these inclusions. In general they appear to have no definite arrangement, but occur indiscriminately throughout the crystals of iron.

A type of unsoundness frequently found is that shown in Figs. 5, 6 and 7; this will be referred to as "metallic-globule inclusions." In general these globules possess a microstructure similar to that of the surrounding metal, but are enveloped by a film, presumably of oxide. It seems probable that they are small metallic particles which were formed as a sort of spray at the tip of the electrode and which were deposited on the solidified crust surrounding the pool of molten metal directly under the arc. These solidified particles apparently are not fused in with the metal which is subsequently deposited over them—i.e., during the formation of this same layer and before any brushing of the surface occurs. By taking extreme precautions during the fusion, a great deal of this unsoundness may be avoided and the mechanical properties of the metal may be considerably improved.

The most characteristic feature of the steel after fusion is the presence of numerous lines or needles within the crystals. The general appearance of this feature of the structure is shown in Figs. 8 to 11 inclusive. The number and the distribution of these needles were found to vary greatly in the different specimens. In general, they are most abundant in the columnar and in the coarse equi-axed crystals; the finer equi-axed crystals in some specimens were found to be quite free from them, although exceptions were found to this rule. In general, a needle lies entirely within the bounds of an individual crystal. Some instances were found, however, where a needle appeared to lie across the boundary and so lie within two adjacent crystals. Several instances of this tendency have been noted in the literature on this subject.[1] The needles have an appreciable width, and when the specimen is etched with 2 per cent alcoholic nitric acid they appear much the same as cementite—i.e., they remain uncolored, although they may appear to widen and darken if the etching is prolonged considerably. The apparent widening is evidently due to the attack of the adjacent ferrite along the boundary line between the two. The tendency of the lines to darken when etched with a hot alkaline solution of sodium picrate, as reported by Comstock,[2] was confirmed. Fig. 10 illustrates the appearance when etched in this manner. The needles are sometimes found in a rectangular grouping—i.e., they form angles of 90 deg. with one another. In other cases they appear to be arranged along the octahedral planes of the crystal—i.e., at 60 deg. to one another. This is best seen in specimens which have been heated, as explained below.

In some of the specimens certain crystals showed groups of very fine short needles (Fig. 11). The needles comprising any one group or family are usually arranged parallel to one another, but the various groups are often arranged definitely with respect to one another in the same manner as described above. Similar needles have been reported in the literature by Miller.[3]

FIG. 5. SPECIMEN AD_9

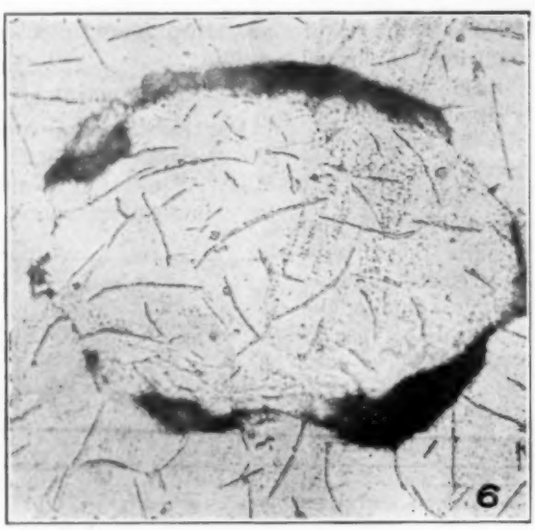


FIG. 6. SPECIMEN A_{10} (HEATED 6 HR. IN VACUO)

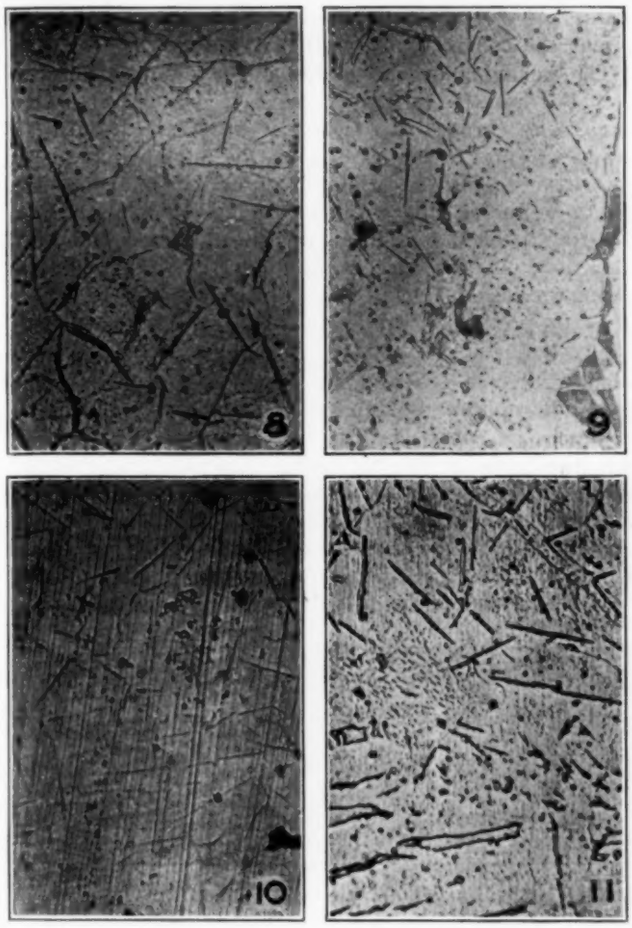
FIG. 7. SPECIMEN AD_{10}

"Metallic-globule" Inclusions in Arc-Fused Iron. Figs. 5 and 7 etched with 2 per cent alcoholic solution of HNO_3. Fig. 6 with 5 per cent picric acid. × 450.

[1] G. F. Comstock, "Microstructure of Iron Deposited by Electric Arc Welding," Bull. 145, American Inst. of Mining Engrs., p. 43. See Fig. 8. E. F. Law, W. H. Merrett, and W. P. Digby, "Some Studies of Welds," *Journal*, Iron and Steel Inst., vol. 83, (1911—I), p. 103. See Fig. 30. J. Caldwell, "Report to the U. S. Shipping Board, Emergency Fleet Corporation, on Electric Welding and Its Application in the United States of America to Ship Construction." (Published by the Emergency Fleet Corporation, 1918), p. 251. See Fig. 14B.

[2] G. F. Comstock, "Microstructure of Iron Deposited by Electric Arc Welding," Bull. 145, American Inst. of Mining Engrs., p. 43. See Fig. 8.

[3] S. W. Miller, "Path of Rupture in Steel Fusion Welds," Bull. 146, American Inst. of Mining Engrs. p. 311.



FIGS. 8 TO 11. CHARACTERISTIC "NEEDLES" OR "PLATES" × 375.

Fig. 8. Specimen BD_9 etched with 5 per cent picric acid in alcohol.
Fig. 9. Specimen BD_9 after using for thermal analysis, reheated in vacuo to 900 deg. C. four times. Picric acid etching.
Fig. 10. Same as Fig. 9 except etched in hot alkaline sodium picrate solution.
Fig. 11. Specimen of welded joint between slip-plate. Additional very small needles are noted. Etching: 2 per cent HNO_3 in alcohol.

An attempt was made by Dr. P. D. Merica to determine whether the so-called lines or needles were really of the shape of needles or of tiny plates or scales. An area was carefully located on a specimen prepared for microscopic examination, which was then ground down slightly and repolished several times. It was possible to measure the amount of metal removed during the slight grinding by observing the gradual disappearance of certain of the spherical oxide inclusions the diameter of which could be accurately measured. By slightly etching the specimen after polishing anew it was possible to follow the gradual disappearance of some of the most prominent needles and to measure the maximum "depth" of such needles. It was concluded from the series of examinations that the term "plate" is more correctly descriptive of this feature of the structure than "line" or "needle." The thickness of the plate—i.e., the width of the needle—varies from 0.0005 to 0.001 mm. and the width of the plate ("depth") may be as great as 0.005 mm. The persistence of the plates after a regrinding of the surface used for microscopical examination may be noted in some of the micrographs given by Miller.[4] The authors are not aware, however, of any other attempt to determine the shape of these plates by actual measurements of their dimensions.

[4] S. W. Miller, "Some Structures in Steel Fusion Welds," *Trans.*, American Inst. of Mining Engrs., vol. 58, p. 700.

Plates Probably Due to Nitrides

The usual explanation of the nature of these plates is that they are due to the nitrogen which is taken up by the iron during its fusion. Other suggestions which have been offered previously attribute them to oxide of iron and to carbide. The suggestion concerning oxide may be dismissed with a few words. The plates are distinctly different from oxide in their form and their behavior upon heating. It is shown later that the tiny oxide globules coalesce into larger ones upon prolonged heating *in vacuo*; the plates also increase in size and become much more distinct (see Figs. 32, 34 and 36). In no case, however, was any intermediate stage betwen the globular form and the plate produced such as would be expected if both were of the same chemical nature.

Regarding the assumption that they are cementite plates, it may be said that the tendency during fusion is for the carbon to be "burned out," thus leaving an iron of low carbon content. In all the specimens, islands of pearlite (usually with cementite borders) are to be found and may easily be distinguished with certainty. The number of such islands in any specimen appears to be sufficient to account for the carbon content of the material as revealed by chemical analysis. In some cases the pearlite islands are associated with a certain type of "lines" or "needles" such as are shown in Fig. 12. These needles, however, appear distinctly different from those of the prevailing type and are usually easily distinguished from them.

The fact that the plates found in the arc-fused metal are identical in appearance and in behavior (e.g., etching) with those found in iron which has been nitrogenized is strong evidence that both are of the same nature. Fig. 13 shows the appearance of the plates produced in electrolytic iron by heating it for some time in pure ammonia gas. These plates behave in the same characteristic manner when etched with hot sodium picrate as do those occurring in arc-fused iron—i.e., they darken slightly and appear as finest rulings across the bright ferrite. The fact that the nitrogen content of the steel as shown by chemical analysis is increased by the arc-fusion also supports the view that the change which occurs in the structure is due to the

FIG. 12

Specimen AD_2, etched with 2 per cent alcoholic nitric acid. Shows pearlite islands, "needles" and oxide inclusions. × 750.

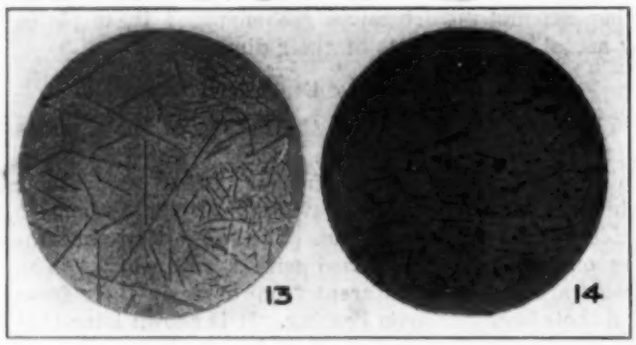


FIG. 13
Characteristic structure of electrolytic iron heated in NH_3 at 650 deg. C. Two types of nitride plates. Etched with 2 per cent alcoholic HNO_3. × 375.

FIG. 14
Arc-fused iron produced in CO_2 atmosphere. Type "A". $\frac{1}{8}$-in. electrodes, 150 amperes. Etched with 5 per cent picric acid in alcohol. × 375.

nitrogen. The statement has been made by Ruder[5] that metal fused in the absence of nitrogen—i.e., in an atmosphere of carbon dioxide or of hydrogen—does not contain any plates and hence the view that the plates are due to the nitrogen is very much strengthened. In Fig. 15 the appearance of specimens prepared at the Bureau by arc fusion of electrodes of type "A" in an atmosphere of carbon dioxide is shown. The microscopic examination of the fused metal shows unmistakable evidence of the presence of some plates, although they differ somewhat from those found in nitrogenized iron and in metal fused in the air by the electric arc. Evidently they are due to a different cause from the majority of those formed in the iron fused in air. For convenience, in the remainder of the discussion the "plates" will be referred to as "nitride plates."

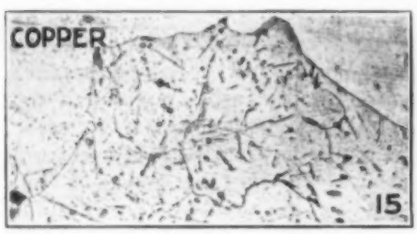


FIG. 15. SPECIMEN B_4

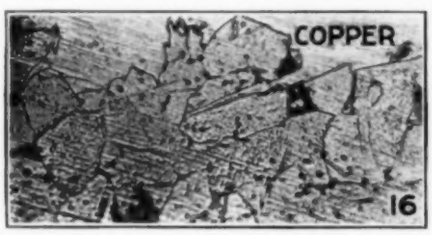


FIG. 16. SPECIMEN B_4

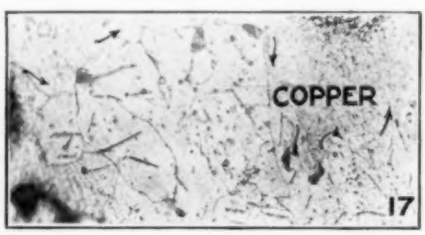


FIG. 17. SPECIMEN B_6

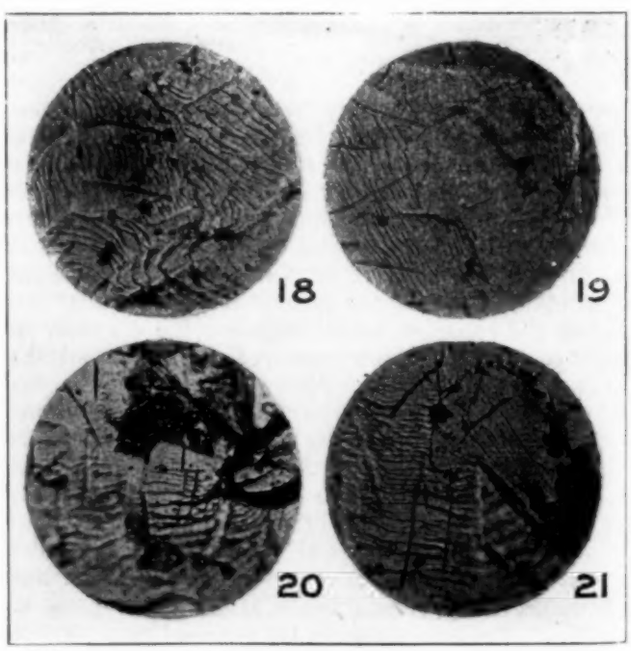
Electrolytic copper deposit for protection during polishing. Etching: 2 per cent HNO_3 in alcohol. × 280.

Relation of Microstructure to the Path of Rupture

The faces of the fracture of several of the tensior specimens after testing were heavily plated electrolytically with copper so as to preserve the edges of the specimens during the polishing of the section and examined microscopically to see if the course of the path of rupture had been influenced to an appreciable extent by the microstructural features. In general, the fracture appears to be intercrystalline in type. Along the path of rupture in all of the specimens were smooth-edged hollows, many of which had evidently been occupied by the "metallic globules" referred to above, while others were gas-holes or pores. Portions of the fracture were intracrystalline and presented a jagged outline, but it cannot be stated with certainty whether the needles have influenced the break at such points or not. Fig. 16 shows the appearance of some of the fractures and illustrates that, in general, the "nitride plates" do not appear to determine to any appreciable extent the course of the path of rupture.

The behavior of the plates under deformation can best be seen in thin specimens of the metal which were bent through a considerable angle. Results of examination of welds treated in this manner have been described by Miller.[6] Small rectangular plates of the arc-fused metal, approximately $\frac{1}{16}$ in. thick, were polished and etched for microscopic examination and were then bent in the vise through an angle of 20 deg. (approximate).

In Figs. 18 to 21 inclusive are given micrographs illustrating the characteristic behavior of the material when subjected to bending. For moderate distortion the nitride plates influence the course of the slip-bands in much the same way that grain boundaries do—i.e., the slip-bands terminate usually on meeting one of the plates with a change of direction so that they form a sharper angle with the plate than does the portion of the slip-band which is at some distance away (Fig. 18). When the deformation is greater the slip-bands occur on both sides of the nitride plate, but usually show a slight variation in direction on the two sides of the nitride plate (Fig. 19); this is often quite pronounced at the point where the plate is crossed by the slip-band.



FIGS. 18 TO 21
Behavior of "nitride plates" during plastic deformation of the iron. Specimen RD_2, etched with 2 per cent alcoholic nitric acid before bending. × 500.

[5] W. S. Ruder, "Metallurgy of the Arc Weld," *General Electric Review*, vol. 21, p. 941.

[6] S. W. Miller, "Path of Rupture in Steel Fusion Welds," Bull. 146, American Inst. of Mining Engrs., p. 311.

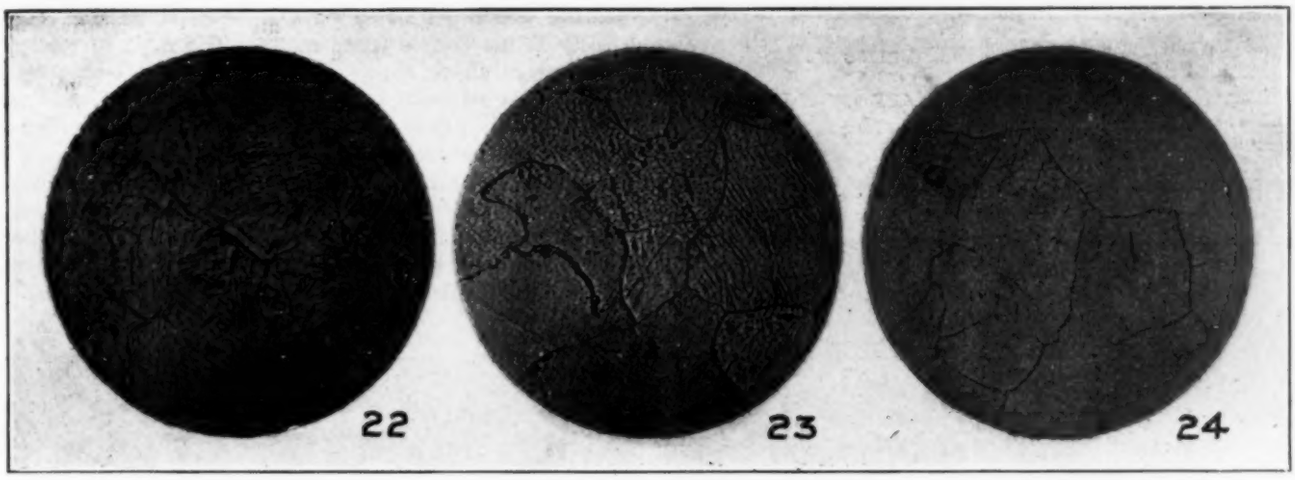


FIG. 22
Specimen AD_{10} quenched in cold water from 1,000 deg. C., suppressing nitride plates and developing martensitic structure. Etched with 5 per cent alcoholic picric acid. × 500.

FIG. 23
"A" electrode quenched in cold water from 1,000 deg. C. Faint martensitic markings, especially near surface. Etched with 2 per cent HNO_3 in alcohol. × 500.

FIG. 24
Same as Fig. 23, but showing interior markings suggestive of "plates" of arc-fused metal. Etched with 2 per cent HNO_3 in alcohol. × 500.

In a few cases evidence of the "faulting" of the plate as a result of severe distortion was noted (Fig. 20). This was a rare appearance, however, because of the unsound nature of the metal.

On account of the inclusions and other features of unsoundness, rupture occurs at such points before the sound crystals have been sufficiently strained to show the characteristic behavior of the plates. Other micrographs show the beginning of a fracture around one of the "metallic globule" inclusions before the surrounding metal has been very severely strained. For this reason the influence of the plates on the mechanical properties of the crystals cannot be stated with certainty. It would appear, however, that on account of the apparently unavoidable unsoundness of the metal, any possible influence of the nitride plates upon the mechanical properties of the material is quite negligible.

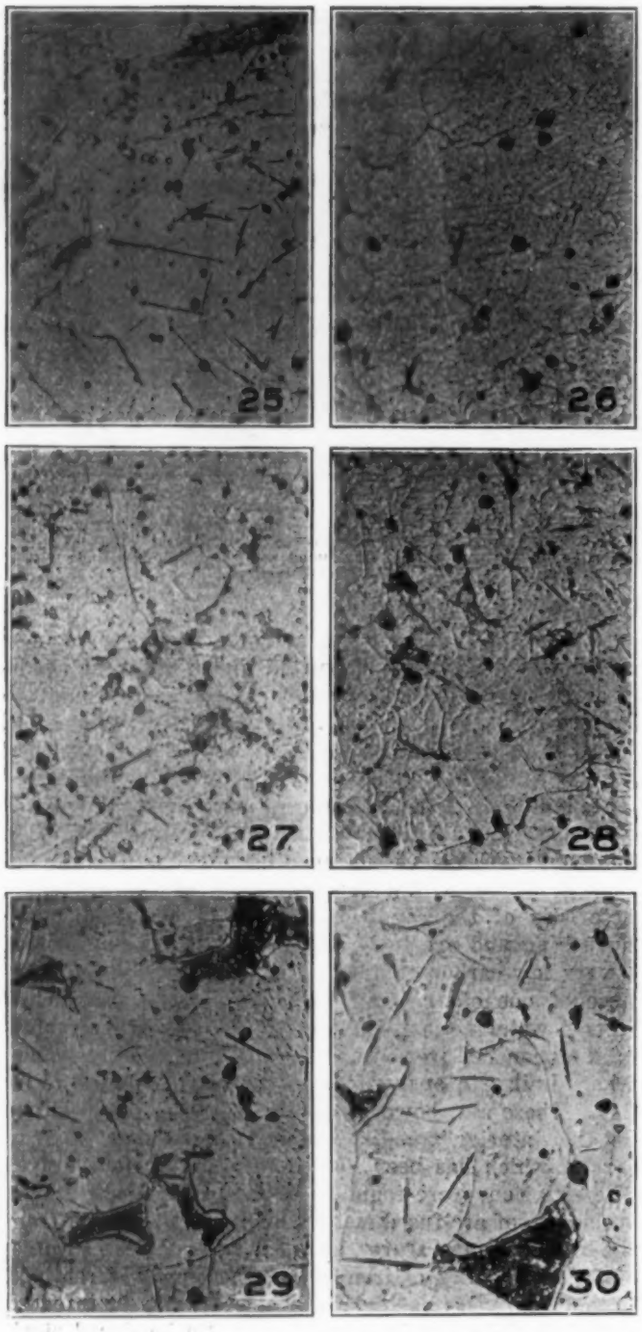
Some of the same specimens used for cold bending were torn partially in two after localizing the tear by means of a saw cut in the edge of the plate. The specimen was then copper plated and prepared for microscopic examination, the surface having been ground away sufficiently to reveal the weld-metal with the tear in it. The nitride plates did not appear to have determined to any extent the path taken in the rupture produced in this manner.

Effect of Heat Treatment Upon Structure

With the view of possibly gaining further information as to the nature of the plates (assumed to be nitride), which constitute such a characteristic feature of the microstructure, a series of heat treatments were carried out upon several specimens of arc-fused electrodes of both types. Briefly stated, the treatment consisted in quenching the specimens in cold water after heating them for a period of ten or fifteen minutes at a temperature considerably above that of the Ac_3 transformation; 925, 950 and 1,000 deg. C. were the temperatures used. After microscopical examination of the different quenched specimens they were tempered at different temperatures which varied from 600 to 925 deg. C. for periods of ten and twenty minutes. The samples which were used were rather small in size, being only $\frac{1}{2}$ in. thick, in order that the effect of the treatment should be thorough, and were taken from test bars A_2, A_3, AD_{10}, B_3, B_4 and B_5. These represented metal which had been deposited under different conditions of current density.[7] No plates were found to be present in any of the specimens after quenching. Fig. 22 shows the appearance of one of the quenched bars, a condition which is typical of all. The structure indicates that the material comprising the plates had dissolved in the matrix of iron and had been retained in this condition upon quenching. The needle-like striations within the individual grains are characteristic of the condition resulting from the severe quenching and are to be observed at times in steel of a very low carbon content. Fig. 23 shows the appearance of one of the "A" electrodes ($\frac{5}{32}$ in.) quenched in cold water from 1,000 deg. C. Some of the crystals of the quenched iron also show interior markings somewhat similar in appearance to the nitride plates (Fig. 24). These are, however, probably of the same nature as the interior tree-like network sometimes seen in ferrite which has been heated to a high temperature.[8] The striations were found to be most pronounced in the specimens of arc-fused metal which were quenched from the highest temperatures, as might be expected. Braune[9] states that nitride of iron in quenched metal is retained in solution in the martensite. The same may be inferred from the statement by Giesen[10] that "in hardened steel, it (nitrogen) occurs in martensite." Ruder[11] has also shown that nitrogenized electrolytic iron (3 hr. at 700 deg. C. in ammonia) after being quenched in water from temperatures 600 to 950 deg. C. shows none of the plates which were present before the specimen was heated.

The sets of specimens (A_2, A_3, AD_{10}, B_3, B_4 and B_5) quenched from above the temperature of the Ac_3 transformation were heated to various temperatures, 600, 700, 800 and 925 deg. C. In all cases the specimens were maintained at the maximum temperature for approximately ten to fifteen minutes and then cooled

[7] See Table VI; "The Physical Properties of Arc-Fused Steel," CHEM. & MET. ENG., Oct. 6, 1920, vol. 23, p. 679.
[8] H. S. Rawdon and H. Scott, Bureau of Standards, Technologic Paper 356. Fig. 2B.
[9] H. Braune, "Influence de l'azote sur le fer et l'acier," *Révue de Met. Memoirs*, 1905, p. 497.
[10] W. Giesen, "Some Notes on the Influence of Nitrogen in Steel," *Carnegie Scholarship Memoirs*, Iron and Steel Institute, vol. 1, p. 1.
[11] G. F. Comstock and W. E. Ruder, "The Effect of Nitrogen on Steel," CHEM. & MET. ENG., vol. 22, p. 399.



FIGS. 25 TO 30. EFFECT OF HEAT-TREATMENT OF ARC-FUSED IRON

All etched with 2 per cent alcoholic HNO_3. × 450.

Fig. 25. Specimen AD_{10} as deposited.

Fig. 26. Same after quenching from above Ac_3 and reheating to 650 deg. C. No "plates" have formed.

Fig. 27. Specimen AD_{10} after quenching from above Ac_3 and reheating to 700 deg. C. "Plates" beginning to reform.

Fig. 28. Specimen B_9 after quenching from above Ac_3 and reheating to 800 deg. C.

Fig. 29. Specimen B_2 after quenching from above Ac_3 and reheating to 925 deg. C.

Fig. 30. Specimen A_2 after quenching from above Ac_3 and reheating to 925 deg. C.

in the furnace. Figs. 25 to 30 inclusive summarize the resulting effects upon the structure. Heating to 650 deg. C. is not sufficient to allow the plates to redevelop, but in the specimens heated to 700 deg. C. a few small ones were found. The effect is progressively more pronounced with the increased temperature of tempering, and in the material heated to 925 deg. C. they are as large and as numerous as in any of the arc-fused specimens. The heating also develops the islands of pearlite which are not always to be distinguished very clearly in the simple fused metal. The work of Ruder[11] referred to above shows that nitrogenized iron which has been quenched and so rendered free from the nitride plates behaves in a similar manner upon heating to temperatures varying from 700 to 950 deg. C.; the plates reappear after a heating for fifteen minutes at 700 deg. C. (or above), followed by a slow cooling. The similarity in behavior of the two is a further line of evidence that the arc-fused metal contains more or less nitrogenized iron throughout its mass.

Plates Remain After Long Annealing

The persistence of the nitride plates was also studied in specimens heated at 1,000 deg. C. *in vacuo* for a period of 6 hr. A set of specimens (one each of test-bars AD_2, A_3, AD_6, A_{10}, B_2, B_6, B_8 and BD_3) was packed in a "usalite" crucible, and covered with alundum sand; this crucible was surrounded by a protecting alundum tube and the whole heated in an Arsem furnace. A vacuum, equivalent to 0.2 mm. mercury, was maintained for the greater part of the 6-hr. heating period; for the remainder of the time the vacuum was equivalent to 0.1 to 0.2 mm. mercury. The specimens were allowed to cool in the furnace. Ruder[12] has stated that 1 hr. heating *in vacuo* at 1,000 deg. C. was sufficient to cause a marked diminution in the number of plates in both arc-weld material and nitrogenized iron and that at 1,200 deg. C. they disappeared entirely.

The results obtained are shown in Figs. 31 to 36 inclusive. In contradistinction to Ruder's work the plates are more conspicuous and larger than before, the oxide specks are larger and fewer in number. Many of the plates appear to have been influenced in their position by an oxide globule. It would appear that the conditions of the experiment are favorable for a migration of the oxide through an appreciable distance and for a coalescing into larger masses. Figs. 32, 34 and 36 all show some cementite at the grain boundaries which resulted from the "divorcing" of pearlite. The oxide is eliminated entirely in a surface layer averaging approximately 0.15 mm. in depth. Only in projections (right-angled corners, sections of threads of the tension bar, etc.), was there any removal of the nitride plates by the action of the continued heating *in vacuo*. This is shown in Fig. 37, which illustrates the removal of the oxide inclusions also. No evidence was found that the small amount of carbon present in the arc-fused metal is eliminated, particularly beneath the surface.

Fig. 6 (page 778) illustrates an interesting exception to the rule that the nitride plates are flat. The general appearance suggests that the "metallic globules" solidified under a condition of "constraint" and that this condition still persists even after the 6-hr. heating at 1,000 deg. C. which the specimens subsequently received.

TABLE I. CHANGE IN NITROGEN CONTENT UPON HEATING

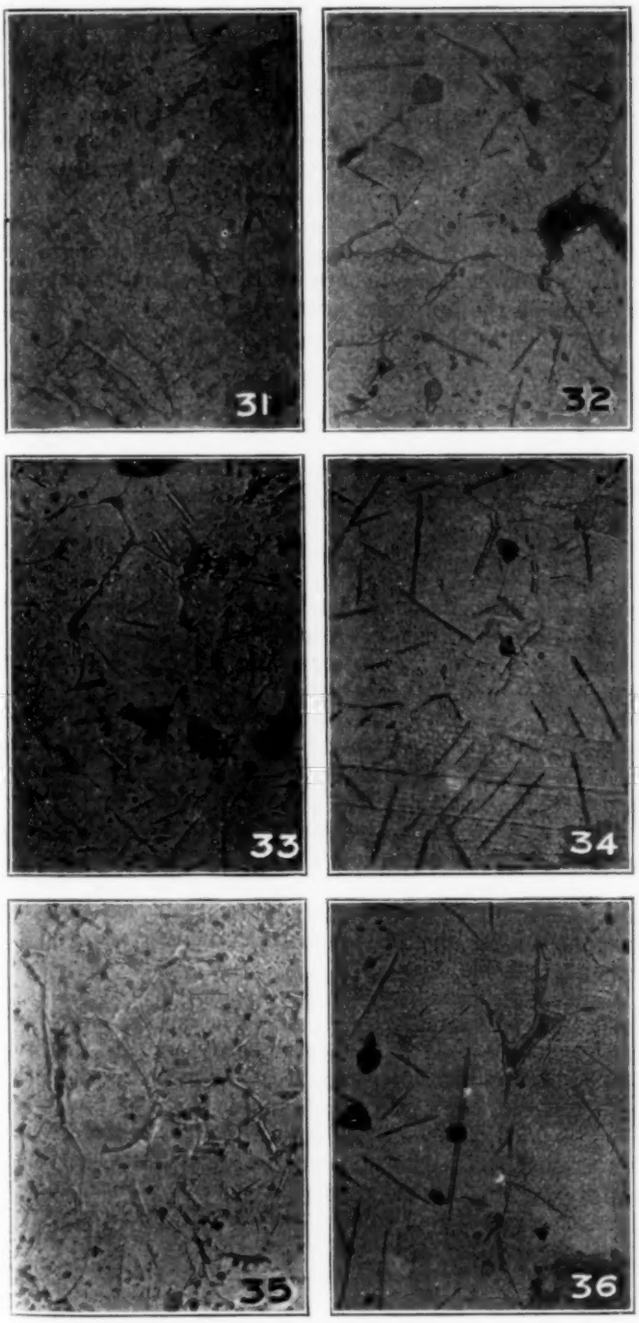
Specimen	Wt. of Sample in Grams.	Average Nitrogen Content, per Cent Before Heating	After Heating in Vacuo.	Loss per Cent
A_2	1.39	0.127	0.062	51
B_4	6.0	0.124	0.078	37
BD_3	1.62	0.140	0.059	57
B_8	1.16	0.121	0.054	55

[11] G. F. Comstock and W. E. Ruder, "The Effect of Nitrogen on Steel," CHEM. & MET. ENG., vol. 22, p. 399.

[12] W. S. Ruder, "Metallurgy of the Arc Weld," *General Electric Review*, vol. 21, p. 941.

Several of the specimens which were heated *in vacuo* (6 hr. at 1,000 deg. C.) were analyzed for nitrogen. The results are given in Table I.

The fact that the specimens lose nitrogen upon heating (although the amount remaining is still many times the nitrogen-content of the metal before fusion), coupled with the fact that the "nitride plates" are larger and more conspicuous after heating than before, suggests very strongly that these plates are not simple nitride of iron. The method used for the determination of nitrogen gives only the "*nitride*" nitrogen, hence a possible explanation for the change in nitrogen content is that it has been converted into another form than nitride and may not have been eliminated from the specimen.



FIGS. 31 TO 36. EFFECT OF 6-HR. HEATING AT 1,000 DEG. C. IN VACUO

All etched with 2 per cent alcoholic HNO_3. × 450.

Fig. 31. Initial structure of AD_2.
Fig. 32. AD_2 after heating.
Fig. 33. Initial structure of B_4.
Fig. 34. B_4 after heating.
Fig. 35. Initial structure of A_{10}.
Fig. 36. A_{10} after heating.

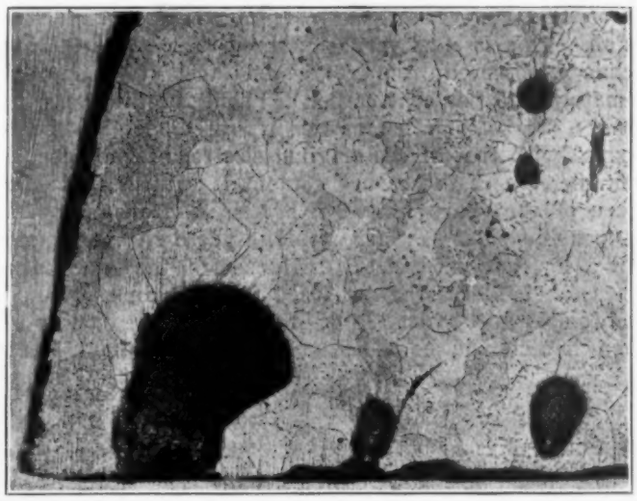


FIG. 37. EFFECT OF PRONOUNCED HEATING UPON THE STRUCTURE OF ARC-FUSED IRON

Specimen AD_{10} was heated for 6 hr. in vacuo at 1,000 deg. C. The micrograph represents a section of the specimen at one corner. The oxide and "nitride plates" have been removed in the exposed tip of the thread. Etching, 2 per cent alcoholic solution of nitric acid. × 450.

Thermal Analysis of Arc-Fused Steel[13]

In order to throw further light on the nature of the plates (nitride) found in the metal after fusion in the arc, the thermal characteristics of the electrode material before and after fusion as revealed by heating and cooling curves were determined. Samples of a $\frac{3}{16}$-in. electrode of type "A" and of the specimen A_1 which resulted from the fusion were used as material (composition in Tables III and VI, CHEMICAL & METALLURGICAL ENGINEERING, Oct. 6, 1920, vol. 23, pp. 677 and 678).

In Fig. 38 are given the curves obtained which show the characteristic behavior of the arc-fused metal upon heating. The commonly used inverse-rate method was employed in plotting the data; the details of manipulation and the precautions necessary for the thermal analysis have already been described.[14] In Table II are summarized the data shown graphically in Fig. 38.

TABLE II. THE THERMAL CHARACTERISTICS OF ARC-FUSED IRON

Rate of Heating and Cooling, Deg. C., per Sec.	Ac_2, Maximum Deg. C.	Ac_3 Beginning	Ac_3 Maximum, Deg. C.	Ac_3 End	Maximum Temp., Deg. C.	Time Above A_3, Min.	Ar_3 Beginning	Ar_3 Maximum, Deg. C.	Ar_3 End	Ar_2 Maximum, Deg. C.
Unfused Electrode										
*	768	892	910	918	960	..	896	893	879	766
0.15	765	897	911	916	960	..	895	891	879	766
Arc-Fused Metal †										
0.14	764	...	847	874	960	28	847	838	820	764
0.13	764	...	849	876	985	42	847	836	822	764
0.13	764	...	844	870	960	29	847	837	821	765
0.13	766	...	850	874	1,035	256	848	835	816	764

* Heated at rate of 0.16 deg. C. per sec., cooled 0.15 deg. C. per sec. For other specimens, the rate of cooling equaled the rate of heating.

† The same specimen was heated four times in succession, as shown in Fig. 38.

The principal change to be noted which has resulted

[13]Credit is due to Howard Scott, assistant physicist, for the work described in this section.

[14]H. Scott and J. R. Freeman, Bureau of Standards Scientific Paper 348.

from the arc-fusion of the iron is in the A_3 transformation. This is now very similar to the corresponding change observed in a very mild steel (e.g., approximately 0.15 per cent carbon). That the difference in the A_3 transformation of the arc-fused metal as compared with that of the original electrode is not due to an increase in the carbon content is evident from the lack of the sharp inflection of the A_1 transformation ("pearlite point") which would, of necessity, be found in a low-carbon steel. No evidence of the A_1 change was observed for the arc-fused iron within the range of temperature from 150 to 950 deg. C. The change in the character of the A_3 transformation is without doubt

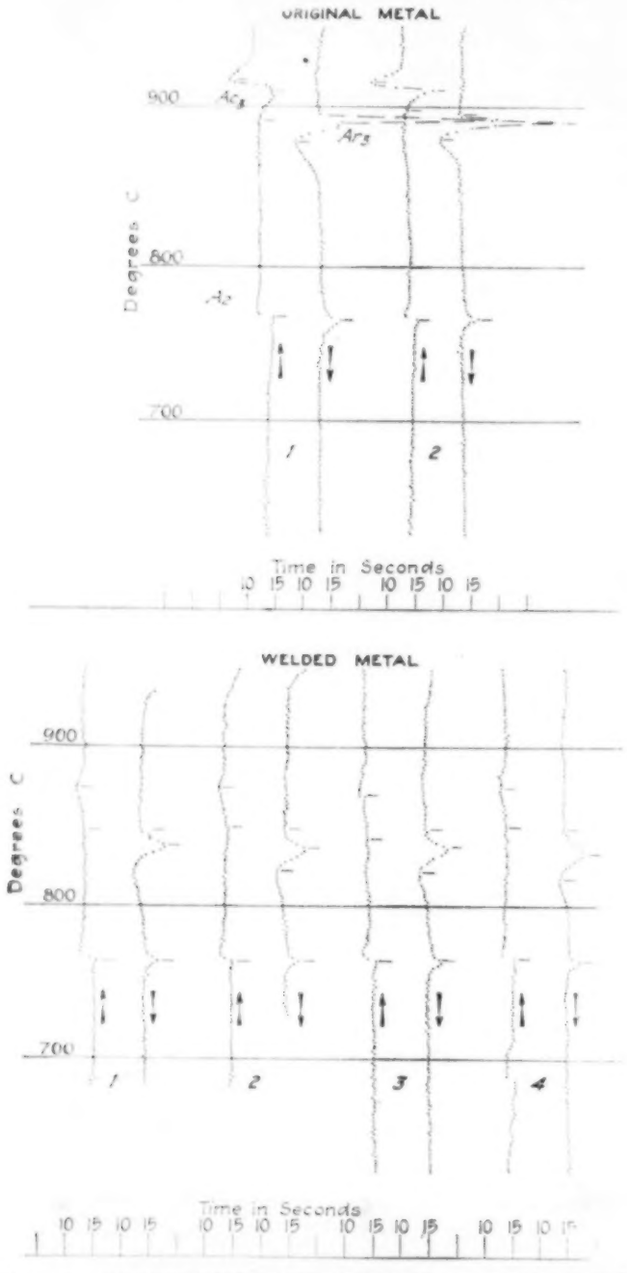


FIG. 38. CURVES SHOWING THE THERMAL CHARACTERISTICS OF ARC-FUSED IRON

The direction of the arrow indicates whether the curve is a heating or a cooling curve.

to be attributed to the influence of the increased nitrogen-content of the iron.

The specimen was maintained above the temperature of the A transformation for a total period (four heatings) of 6 hr., the maximum temperature being 1,035 deg. C. The transformation apparently is unaffected by the long-continued heating, thus confirming the results described in the preceding section.

In discussing the properties of steel nitrogenized by melting it in nitrogen under pressure, Andrews[15] states that it was found possible to extract almost entirely the small quantities of nitrogen by heating a specimen at 1,000 deg. C. *in vacuo* for periods of 1 to 6 hr. The metal used contained 0.16 per cent carbon and 0.3 per cent nitrogen. Thermal curves are given to show that there are no critical transformations in the material; the nitrogen suppresses them. They gradually reappear, however, as the nitrogen is removed by heating the material *in vacuo* at 1,000 deg. C. Several days' heating was required, however, to obtain an entirely degasified product, the carbon being removed also. A further statement is made that a steel of 0.6 per cent carbon content containing 0.25 per cent nitrogen can be brought back to the normal state of a pure steel only by several weeks' heating *in vacuo*.

The results of the thermal analysis add considerable confirmatory evidence to support the view that the plates existing in the arc-fused metal are due to the nitrogen rather than to carbon.

Summary

Microscopic examination of bent pieces of arc-fused metal show that the metallic grains are inherently ductile, even to a high degree. Grosser imperfections, however, are entirely sufficient to mask this mark of excellence.

The view that the characteristic features observed in the structure of the arc-fused iron are due to the increased nitrogen content is supported by several different lines of evidence. These include the likeness of the structure of the material to that of pure iron which has been "nitrogenized," the similarity in the behavior of both arc-fused and nitrogenized iron upon heating, the evidence shown by thermal analysis of the arc-fused metal, together with the fact that, as shown by chemical analysis, the nitrogen content increases during fusion, while the other elements, aside from oxygen, decrease in amount. The characteristic form in which oxide occurs in iron, together with its behavior upon heating, renders the assumption that the oxide is responsible for the plates observed in the material a very improbable one.

Judged from the results obtained, neither type of electrode appears to have a marked advantage over the other. The use of a slight protective coating on the electrodes does not appear to affect the mechanical properties of the arc-fused metal materially in any way. The specimens were prepared in a manner quite different from that used ordinarily in electric-arc welding and the results do not justify any specific recommendations concerning methods of practice in welding.

In addition to the credit given throughout the text to those who have co-operated in various phases of the investigations, the authors wish to acknowledge the help of H. L. Whittemore and R. W. Woodward for the aid in the necessary mechanical testing and to F. H. Tucker for the general chemical analyses made during the progress of the work.

Bureau of Standards,
Washington, D. C.

[15] H. H. Andrews, "Iron and Nitrogen," *J. Iron and Steel Inst.*, vol. 86 (1912—II), p. 210.

The Disk, Plate and Cylinder Processes for the Production of Carbon Black

Description With Mechanical Details of Disk, Plate and Cylinder Process Carbon Black Plants — Driving Mechanism and Heat Variations—Comparison of Processes

By ROY O. NEAL

THE small rotating disk, ring or Blood process was invented by A. R. Blood in 1883 and is extensively used at the present time. The disk upon which the carbon black is deposited is shown in Fig. 1. It is made of cast iron, varies in diameter from 36 to 42 in. and has a 50-in. face. The lava tips are set in a circular piece of ¾-in. standard pipe, which is about 28 in. in diameter and contains from eighteen to twenty-four tips. The scraper for removing the carbon is in contact with the disk continuously and is set over a hopper radially with the disk.

A driving gear bolted on the disk, and a pinion meshing with the gear, are attached to the drive shaft by means of a setscrew. The teeth of the pinion are extraordinarly long to allow for expansion and contraction of the entire length of the driving shaft. A shaft base or cap sets in the axis upon which the disk rotates and acts as a guide and support for the driving shaft. It also makes the pipe, that sets on a concrete base and carries the weight of the disk, more rigid and stable. The gear and pinion actuate the disk, which makes one revolution in about 15 min. Details of a wheel, driving gear and pinion, and shaft base are given in Fig. 2. An assembly drawing of a gear and pinion, shaft base and accessories is shown in Fig. 3, although a disk is used of different design than that above described.

The disks are arranged in rows having twenty-one disks per row, with either two or four rows per building, although the latter is the more common practice. One unit plant has from sixteen to twenty buildings, so that there are eighty-four disks per building and 1,532 disks in an 18-building factory.

Each pair of rows has one conveyor and each row has a separate drive shaft extending the entire length of the building. The drive shafts are moved by a gear and pinion, power being transmitted by a 2-in. shaft located in the alley. Fig. 4 shows how the power is transmitted to a building having four rows of disks.

The carbon black is delivered from the buildings and proceeds the same as in the channel process. No gear-shifting machine is employed and the shafting is lighter than in the channel system, as the weight of the material in the condensing buildings of a typical plant using the rotating disk method is about 150 tons.

The quality and yield of the carbon black made by the disk process is approximately the same as that made by the channel method.[1]

The "Plate" or Cabot Process

The plate system was invented by Godfrey L. Cabot about thirty years ago and has two modifications, one consisting of stationary plates 24 ft. in diameter beneath which are revolving scrapers and burners that are supplied with gas, and the other, using revolving plates 24 ft. in diameter, having stationary scrapers and burners. The first arrangement is chiefly used and is employed at a plant in West Virginia which until recently had the largest output of any factory in the world. This plant had 113 plates and is shown in Fig. 5. This process is also used in Louisiana.

The plates are made of forty-eight segments, sixteen in the inner row and thirty-two in the outer row, the over-all diameter being 24 ft. The plates are perforated with ventilator holes to allow the products of combustion to escape and afford a means of maintaining a draft. The plate is supported by guys which are screwed into a cap having approximately the shape of a very broad truncated cone. This cap rests upon the top of a hollow mast, the joint between the cap and the mast being made gas-tight with asbestos.

The plates are surrounded by a circular building made of corrugated sheet iron and are 26 ft. in diameter. Above each plate is a roof made partly of triangular pieces of sheet iron and partly of four-sided sheets of corrugated iron that extends about two-thirds of the distance up the 16-ft. mast, leaving, therefore, in the center an open space having about one-third the diameter of the plate, through which the products of combustion can escape.

The mast stands in a bed-plate, the upper surface of which carries a groove in which run steel balls as a bearing. Upon these steel balls rests a casting having eight arms projecting outward and upward that fit into the lower ends of struts made of 2-in. pipe. On the outer end of these struts is an angle casting into which the pipe fits, and a horizontal hole which accommodates a horizontal guy rod. Each horizontal guy is connected at the inner end to an octagonal plate which rotates with the burners around the central mast.

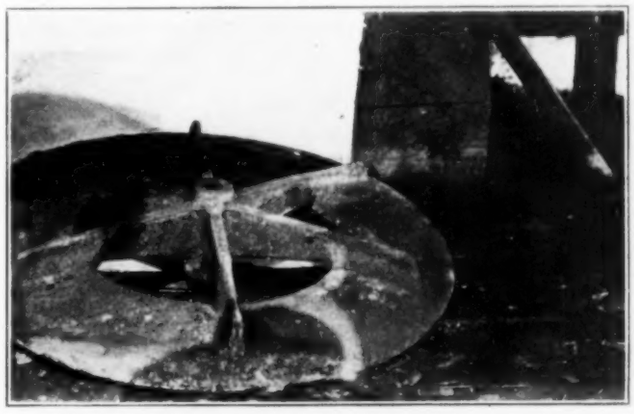


FIG. 1. DISK CARBON DEPOSITING SURFACE

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[1] See CHEM. & MET. ENG., vol. 23, No. 15, Oct. 13, 1920, p. 729.

The scrapers and burners revolve around the central mast and the burners fit in a gridiron of pipe lying on a circle of 4¼ x ¼-in. bar iron which is bolted to the vertical face of the angle castings. The lamp is fed by two ¾-in. holes in the central mast incased in a gas-box with stuffing boxes and glands above and below. This gas-box revolves around the mast supported on the

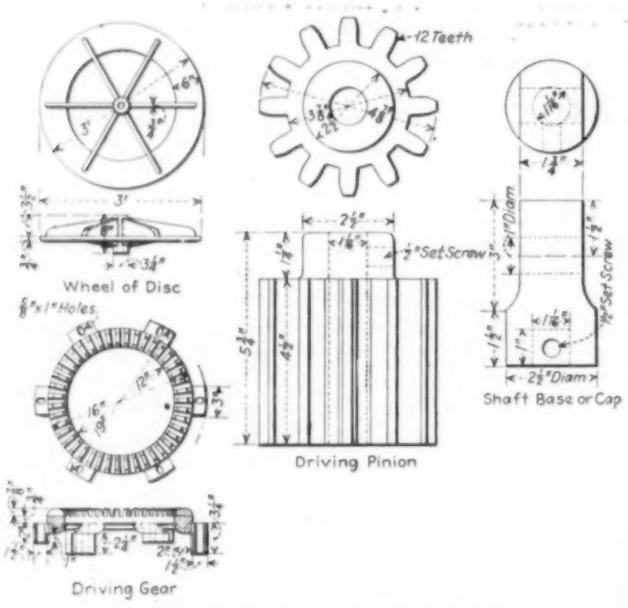


FIG. 2. DETAILS OF DISK AND DRIVING MECHANISM

eight-horn casting with the burner pipe, radial black box, etc.

The gas line from the regulators is connected to the bottom of the mast, this mast closed above by a cap from which depend the oblique guys. Slightly below the scraper box are the ¾-in. perforations that admit the gas into the gas-box. To the gas-box are connected two 1½-in. pipes feeding a 4-in. main in which are screwed the 1¼-in. burner pipe extending beneath the surface of the depositing plate. Each 4-in. pipe feeds over fifty 1¼-in. pipes, equidistant from one another and extending to the periphery, the circular depositing plate. The 1-in. pipes carry the lava tips, that are the same as those in the channel or disk process. The two center pipes have sixty lava tips each, and there are 1,265 tips under the entire plate. The burners make one revolution in 8 min.

The black is removed from the plates by scrapers placed radially to the mast. Below the scrapers is a collecting box that carries a screw conveyor, the shaft of which is actuated by a gear and pinion. The gear sits on the mast and the pinion on the end of the conveyor shaft. The carbon is carried to the inner end of the

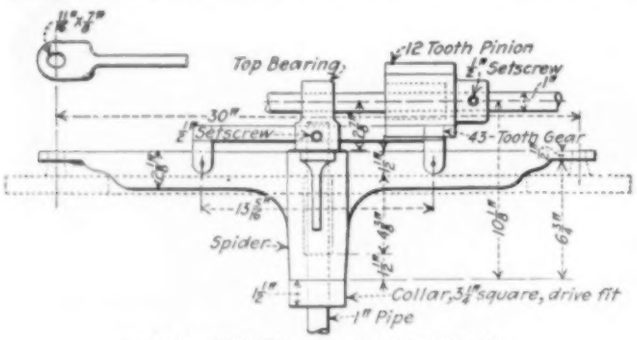


FIG. 3. SPIDER, GEAR AND PINION

collecting box and descends through a vertical pipe into a circular box that discharges downward into a long conveyor which runs beneath the circular boxes and 2 ft. from the center of the ring. The black is carried from several plates by conveyors that bring it to the packing house, in which it is elevated to bins, from which it is dropped into the packing machines.

All the machinery at these plants moves very slowly so that a surprisingly small amount of power is used. Only one 35-hp. gas engine is necessary to operate twenty-two plates. This includes power for conveyors, packing and bolting machinery.

The writer is indebted to Godfrey L. Cabot for a great deal of the information concerning this system.

Roller or Rotating Cylinder Process

The roller process was first used by E. R. Blood in 1883, but at first was unprofitable owing to the small yield. Later, however, the operation details were improved and a market for this product, which possesses valuable properties notwithstanding its inferior color, has been created. At the present time this product sells for the highest price of any grade of carbon black and supplies a limited market, being utilized chiefly in making lithographic and embossing inks, and printing ink for half-tone prints.

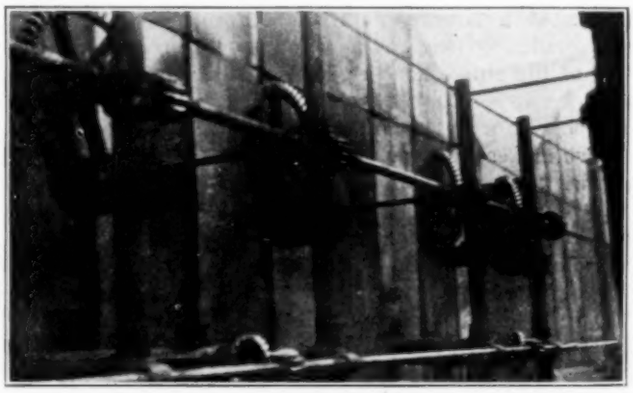


FIG. 4. DRIVING MECHANISM IN DISK PROCESS

The buildings or benches in this method are from 65 to 100 ft. in length and from 25 to 35 ft. in width, being made of 24-gage straight or V-crimped sheet iron, and wired to a small angle-iron framework. From four to ten buildings are connected to the same driving shaft or source of power.

The gas is reduced in pressure as in other methods and led to each set of rollers or cylinders by means of a 1¾-in. pipe. Some manufacturers place a small disk in the screw union in each distributing pipe before it is connected to the pipe carrying the lava tips in order to regulate the flow of the gas uniformly under each roller. The burner pipe holding the lava tips is from 3 to 5 in. below the cylinders and in most cases is lower than in the channel system. The lava tips are round and have a round perforation instead of a fishtail opening. The flame issuing from the tips is cylindrical. The tips are separated by ⅞ in. to 4 in., as is shown in Fig. 6.

The rollers are from 3 to 8 ft. in length, having a spider bearing for a 1½-in. shaft. If made of cast iron they are about ⅞ in. thick and 8½ in. (outside diamensions) in diameter, weighing approximately 100 lb. The outside of the rollers is machine faced. Some operators use ordinary extra heavy casing in 8- or 9-ft. lengths and place spider bearings by means of countersunk

rivets in each end in the center for the shafting. This arrangement is cheaper and makes the plant more independent of the local foundries, although there is a possibility of the cylinders warping, consequently throwing the driving mechanism out of alignment. At a plant using casing no difficulty was experienced due to warping, distortion or scaling by heat.

The scrapers for removing the deposited carbon black are located at the direct top of the rollers or near the top, and run longitudinally the entire length of the rollers. They are in direct contact with rollers and scrape continuously. On one design V-shaped blades

FIG. 5. PLATE PROCESS PLANT

are attached to the opposite ends of downwardly curved metal straps. One of the blades is positioned for contact with one of the rollers and one for another roller. The weight of the straps and blades is borne by the cylinders, and is sufficient to cause the blades to come into close contact with the rollers and perform their scraping function efficiently.

Over the cylinders is located a removable sheet iron hood, provided with apertures for controlling the ventilation within the roller chamber. This hood also protects the cylinders against drafts. Arranged below the cylinders is a trough-shaped hopper contracted at the bottom and designed to shut out the air from the cylinders and to collect the black which is scraped therefrom. A screw conveyor is mounted in the bottom of the hopper and carries the black to the bolting machines, thence to the storage bins, from which it is taken by the packing machines. The hood, hopper and conveyors are supported by an angle-iron frame. Under each hood are nine rollers, three rollers on each shaft. Where 4-ft. rollers are used there are only two rollers on each shaft, and in some designs there are only two sets of rollers to a hopper. There are two rows of hoods and hoppers to the building, with the shafting running the entire width of the building—that is, each shaft will actuate four or six rollers, depending upon the length of the cylinders. The draft is also regulated by slits or slide doors in the building itself. A typcial building, then, would have from 196 to 288 rollers, 10,000 lava tips and about twenty-four to thirty-two hoods and the same number of hoppers.

On each shaft, which is made of hollow pipe, a worm gear with about twenty-eight teeth and a pitch diameter of about 6 in. is attached by means of a setscrew. This gear is actuated by a worm 3 or 4 in. in diameter and having about five threads. This makes one revolution every 15 to 45 min., the grade of black determining the rate at which the cylinders revolve. The worm is mounted on a solid steel shaft moved by a chain and sprocket transmission from the main power line. The conveyors, elevators, bolting machines and packing machines are also connected from the main power shaft, that is actuated by the gas or expansion engine. The power requirements are about the same as with the channel method. Fig. 7 shows details of this system.

Gears

A large number of gears are necessary in the machinery for making carbon black. Most of the gears used are bevel, since power is transmitted to the conveyors by this type, although spur gears are made use of in power transmission to bolters, scalpers, etc., and worm gears move the cylinders in the roller process and transmit power from reversing gear shift to main drive shaft, that actuates the rack and pinion in the channel system. Fig. 8 shows a typical spur gear and pinion. The letters refer to:

Gear		Pinion	Gear		Pinion
Pitch* (circular)	= C.....	c	Diameter of hub	= H.....	h
Face	= F.....	f	Outside diameter	= D.....	d
Bore	= B.....	b	Length of hub	= L.....	l
Pitch diameter	= D'.....	d'	Projection of hub	= P.....	p

* Diametral pitch is the number of teeth to each inch of pitch diameter. The word "diameter" when applied to gears is always understood to mean pitch diameter.

If the teeth are properly shaped and the linear velocities of the two wheels are equal, then the angular velocities or speeds of rotation are inversely proportional to the number of teeth and to the diameters. Thus a gear that has twice as many teeth as one mating with it will revolve just half as many times per minute.

In ordering standard gears and pinions it is only necessary to specify circular pitch, bore, face and ratio of number of teeth on gear to number of teeth on

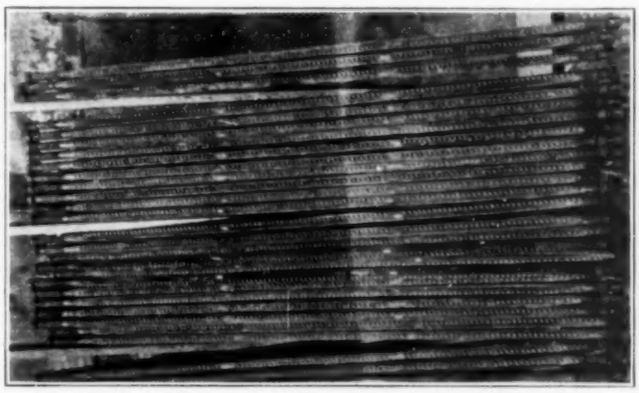


FIG. 6. GAS BURNERS USED IN ROLLER PROCESS

pinion. The width of the faces of teeth is generally made two or three times the circular pitch, although there is no standard rule.

A special gear problem characteristic of carbon black industry arises due to the heat changes. This difficulty is solved by using pinions whose facial dimensions are four or five times that of the gears so that should sudden expansion or contraction result in shaft the gear and pinions will still mesh. Should bevel gears be used, contraction might possibly prevent the intermeshing and upon expansion the teeth might break or force shafting out of alignment, causing a waste of power and undue wear upon gears and bearings—in fact, some bevel gears have worn away as much as $\frac{3}{4}$ in. from this cause. Quite frequently a device is resorted to which is not strictly mechanical, but which, nevertheless, gives good results under the wholly peculiar conditions of this industry—namely, a bevel wheel is driven with a spur

gear. The bevel is very flat, perhaps five or six times the pitch diameter of the spur that drives it. Obviously the wear and tear on the cogs is uneven and greater than a true bevel properly adjusted would give, but this rough and ready contrivance has the great advantage that as the shaft, on which sit the spur gears, comes and goes with expansion and contraction the cogs on the spur wheels are so long that they always engage the teeth of the bevel gear, and as the power required is very small in proportion to the size of the gears and the motion very slow the extra wear and friction caused by this mathematically inaccurate method are of minor importance, far less injurious in actual practice than the evils that might otherwise result by the expansion and contraction of the driving shaft. Some of the gears installed in carbon black factories are not standard, but are "bastard" gears and are cast from special patterns.

In the disk process especially gears are exposed to an intense heat that practically eliminates the possibility of lubrication, so that wear and frictional losses are necessarily large, though maximum service is obtainable by:

1. Correct installation, which must take into account that old, badly worn gears will unduly wear new pinions and *vice versa*.
2. Proper maintenance, which means that gears must be kept in mesh on true centers in proper alignment. This necessitates proper maintenance of bearings.
3. Lubrication where possible.
4. Inspection at intervals.
5. Ample strength, ductility and wearing surface, hardness in gears and pinions.

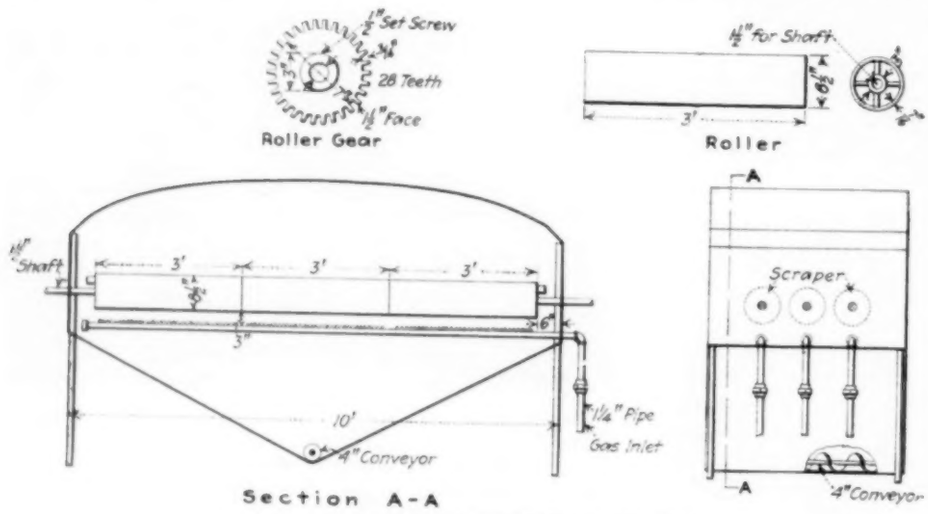


FIG. 7. DIAGRAM OF CYLINDER PROCESS

If the proper attention is not given, the gears soon fail to mesh accurately and serious evils result, such as:

(*a*) Power escapes in transmission.

(*b*) Bearings wear unevenly, throwing shafts out of line. This is turn causes gears, bearing and other parts to wear faster.

(*c*) Vibration is produced in the gears, resulting in increased wear and tear.

Thermal Decomposition

Several patents have been granted on cracking or thermal decomposition methods of producing carbon black from natural gas, but at the present time only one company is operating on a commercial basis, and this concern is decomposing the gas for the hydrogen and is not even collecting the carbon formed.

The carbon black produced by this procedure contains adamantine or hard particles, is grayish in color and possesses a high apparent specific gravity. One sample

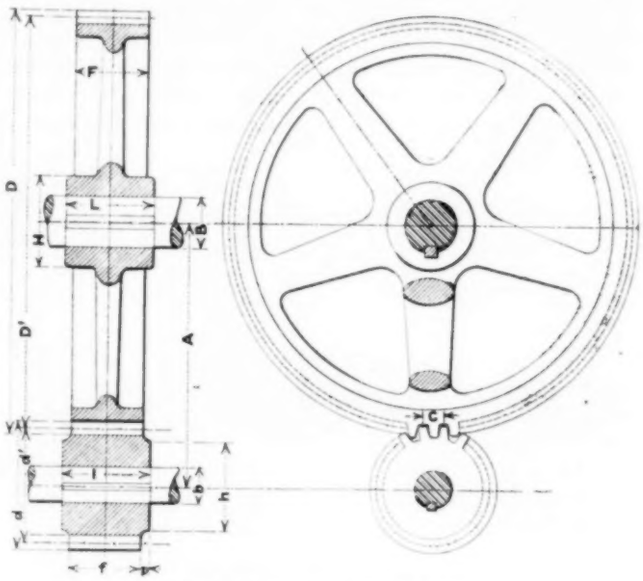


FIG. 8. GEAR AND PINION

that the writer examined contained 5.38 per cent matter that was soluble in chloroform and possessed only one-fifth the tinting strength of ordinary carbon black. Some of the product showed flakes of naphthalene, so that its utility in the rubber tire industry is very much impaired—in fact thus far the product made by thermal decomposition is almost unmerchantable and has been used successfully only in making cheap paints and has sold for from 1c. to 2c. per lb. In one process a large pipe with walls 1½ in. thick is erected in a vertical position. The gas is introduced in the lower portion of the pipe and ejected from a side connection located near the top. A temperature of 1,500 deg. F. is maintained by several circular rows of gas torches. The carbon, deposited upon the inner walls of the pipe, is released by a revolving mechanism. This mechanism consists of a shaft to which chains are attached running the entire length of the furnace. Upon revolving, the chains scrape the carbon from the inner wall of the pipe. The difficulty with this process is the rapid deterioration of pipe and the large content of iron scales in the carbon black. From 8 to 10 lb. has been obtained per 1,000 cu.ft. of gas, but the product is of no commercial value.

In another process the cracking chamber is lined with firebrick and is heated to 1,500 deg. F. by admitting at intervals a blast containing a mixture of air and gas. The carbon liberated is carried over by the blast of gas and collected in separators or bags.

The channel, rotating disk and large plate methods give approximately the same yield of black per 1,000 cu.ft. of gas. The roller system produces considerably less carbon than any of the other processes, but the resultant product is much more valuable and is utilized for highly specialized purposes. Table I shows the yield procured by various processes in different fields.

TABLE I. YIELD OF CARBON BLACK IN DIFFERENT FIELDS

Plant No.	State	Process	Lb. of Carbon Black per 1,000 cu.ft. Gas
1	Louisiana	Channel, 2-table	0.78
2	Louisiana	Channel, 1-table	0.95
3	Louisiana	Channel, 1-table	0.80
4	Louisiana	Large plate	0.80
5	West Virginia	Large plate	1.10
6	West Virginia	Rotary disk	0.95
7	West Virginia	Roller	0.80
8	West Virginia	Rotary disk	1.00
9	West Virginia	Channel, 2-table	1.12
10	West Virginia	Channel, 1-table	1.30
11	West Virginia	Rotary disk	1.40
12	Oklahoma	Channel	1.20
13	Wyoming	Channel	1.40

The channel system has the advantage that plants can be constructed almost entirely from standard forms, thus making the enlargement of this type of plant convenient. The cost of construction is less than any of the other types of factories.

The large plate method has the disadvantage of requiring special castings which are so large as to entail a greater initial cost of construction. However, they are advantageous when erecting a plant capable of producing a large output in that the power requirements are less than those of the other methods.

TABLE II. COMPARISON OF DIFFERENT METHODS

Plant No.	Location	Method	*Sq.ft. per Burner Tip	Sq. ft. per Lb. of Carbon Black	Sq. ft. per 100 cu.ft of Gas Burned
1	Louisiana	Channel, 2-table	0.21	4.87	3.73
2	Louisiana	Channel, 1-table	0.26	4.23	4.04
3	West Virginia	Roller	....	9.10	7.33
4	West Virginia	Large plate	....	6.53	7.16
5	West Virginia	Channel, 2-table	....	5.05	6.75
6	West Virginia	Small disk	....	3.10	2.90
7	Oklahoma	Channel, 1-table	....	3.70	3.50

*Sq. ft. of depositing surface.

The rotating disk process requires a special casting, but has the preference over the channel method in that the plants are more elastic. Part of the disks in a condensing building may be out of order, still the remaining rings will operate and it is not necessary, as in the channel method, to eliminate an entire condensing building.

A plant using the roller system produces the smallest yield and requires the largest depositing surface per lb. of black made and per 1,000 cu.ft. of gas burned (see Table II) of any type of plant. The demand for the product made by this process is small and the present production is sufficient to supply the present demand.

Japanese Matches

The export of Japanese matches, which during the war monopolized many of the world's markets, is now steadily decreasing, says the *Japan Chronicle*. Most of the trade now goes to Hongkong and the southern part of China. Exports during July reached a value of $84,399, which was a decline of $25,693 below the previous month and of $41,126 below July, 1919. Enormous stocks have accumulated on the Kobe market, where the prices in August showed a slight increase over July.

Commercial Retorting of Oil Shales

By Louis Simpson

IT HAS been predicted that within two years gasoline will reach the record price of 75c. per gal.

It is known that there are many millions of tons of oil-yielding shales in the United States, distributed not over one or two, but probably over a majority of the states and that money to develop those properties and retort the shale should be readily obtainable.

These premises being admitted, it is natural to ask, Why should there be any scarcity of crude hydrocarbon oil or of gasoline—a fractionated product of crude oil? There can be no effect without a responsible cause or causes. It is therefore necessary to seek the cause or causes.

When the extent of the wealth of the oil-yielding shale deposits began to be appreciated by the officials of the United States Bureau of Mines, these officials widely recommended those interested in the utilization of these neglected natural deposits to use the style of retort that for many years had been successfully operated in Scotland. This unfortunate advice, given in all good faith, has proved to be a veritable stumbling block in the way of the development of the industry, for the following reason: It has been found (and after years of contention it is now generally admitted) that the Scotch style of retort, the result of development influenced by local conditions peculiar to Scotland, is not the most suitable or the most economical form of retort when used under conditions widely and essentially different from those existing in Scotland.

Claims of the Scotch

The Scotch, because they had made a success of the retorting of the Scotch oil shales, took every opportunity of making it known to the world that the Scotch oil-yielding shales were the only true oil shales, that the Scotch retort was the only possible retort and that the Scotch-trained shale engineer was the only engineer who knew anything about the oil-shale business. These claims, which have no foundation in anything but in the Scotch imagination, have so frightened the capitalist that the necessary capital in sufficiently large amounts has not been available, capitalists preferring to wait until the retort question was settled.

It is now known that Scotch experience, unmodified by other experience, has in the past proved detrimental instead of advantageous when operations had to be conducted under conditions greatly different from those existing in Scotland. It is now admitted that the chemical principles that underlie the process of retorting oil-yielding shales as carried out in the Scotch retort are correct, but it has had to be granted that, in the application of those principles, there is much that can be improved.

Moreover, even were the application of the principles the best when applied to retorts retorting Scotch shales under Scotch conditions, such application might not and probably would not be the best when the retort is required to retort shale of a different character and quality under conditions that are different.

The shale found in Scotland, needless to say, is not, as claimed, the only true oil shale. Any shale that contains "kerogen" is a true oil shale. The base of such shale may consist chiefly of silica, alumina or lime. The shale may contain a small or a large per-

centage of fixed carbon, it may contain nitrogen and potash in comparatively large or in very small quantities. Hence the variations in quality may be and are very wide.

Further, the oil obtained from the shale may be chiefly of a paraffine, or, on the other hand, of an asphalt base or it may be relatively free from sulphur or have a relatively high sulphur content, all factors affecting the value of the oil.

Differences Affecting Commercial Value of Oil-Yielding Shale

To summarize, differences that affect the commercial value of oil-yielding shale are:

1. Base of the sedimentary deposit, whether silica, alumina or lime.
2. Base of the recovered oil, whether paraffine or asphalt.
3. Relative percentage of sulphur in the oil.
4. Fixed carbon content of the shale, which may be less than 2 per cent or more than 20 per cent.
5. Quantity of oil recoverable, which may be less than 10 gal. or may exceed 75 gal. per ton.
6. Quantity of nitrogen recoverable as ammonium sulphate, which may be less than 20 lb. per ton and may exceed 100 lb. per ton.
7. Quantity of potash recoverable. In only a few cases will it be found profitable to recover the potash content.
8. Spent shale. This generally is of no value, but should the shale be of a lime base it may at times be profitably used in the manufacture of portland cement.

Location and Character of the Deposit

The location of the deposit may be favorable or otherwise. The deposit may be near a railway or may be at a considerable distance from any railway communication.

It may be necessary to undertake expensive pipe lines, also wharves, with all the attendant expenses of tanks, etc.

It may be necessary to invest much capital in tank cars, while in other cases one or more of these capital expenditures may not be necessary.

As the shale itself differs within wide limits, so also may the character of the deposit.

In Scotland shale has for some years past been recovered by deep mining, some having been mined at a depth of 2,000 ft., at a commensurately high cost for such mining.

The deposits as known to date may be divided:

1. Horizontally bedded deposits, being the top strata of hills, covered by an overburden that can be economically removed.
2. Horizontally bedded deposits, that can be mined from tunnels or adits driven into the hillside. These may be subdivided into those where the roof is good and those where the roof has been badly disturbed, also into those where the shale beds are from 3 to 8 ft. thick and those where the shale beds are thinner than 3 ft. or thicker than 8 ft.
3. Deposits more or less horizontally bedded, forming the bottom of a valley. These can be subdivided as follows: (*a*) Those covered by a slight overburden. (*b*) Those where the overburden is considerable, yet not too deep to be economically removed. (*c*) When it is more economical to bypass certain lean beds.
4. Deposits, now vertical in position, which are made available by the erosion of water, making it possible to remove the shale by quarrying or by modified shovel work. These can be subdivided into those that are covered with but slight overburden and those where the overburden is heavy.
5. Deposits, now vertical in position, appearing as bands of shale extending down the sides and the bottom of valleys, being the remains of synclinals, the anticlinal portions of the formation having been eroded.
6. Deposits such as are found in Scotland, that have to be recovered by deep mining, these being subdivided according to the depth that has to be mined.

Methods of Mining

Deposits 1, 3, 4 and 5 can all be excavated by the use of steam-operated, or better still, electrically-operated shovels. This method of mining costs considerably less than the method required in deposit 2 and immensely less than that called for in deposit 6. The difference is so great that it is possible that a deposit giving a low yield of oil, but which can be mined by shovels, will prove more remunerative to operate than a deposit which, although it is rich in oil, has to be mined as deposit 2, typical of the Colorado shales, or as 6, typical of the Scotch shales. The difference in the cost of mining and assembling at today's cost may exceed $2 per ton of shale, which is a profit in itself.

Unfortunately the shovel method of mining cannot economically be undertaken unless the daily tonnage mined is considerable, hence it is necessary that the industry should be undertaken by concerns prepared to expend the capital necessary to construct works of considerable throughput.

Expenditures and Returns

As stated by Martin J. Gavin in his article "Oil Shales and Their Economic Importance," published in Chemical & Metallurgical Engineering, Aug. 18, 1920: "The oil-shale industry will require the expenditure of many millions of dollars." Mr. Gavin, however, is not correct when he claims that an investor "will probably have to wait for a long time for a return on his investment and that returns will probably be conservative."

There is nothing to warrant such a statement. Given a property, well selected as to location, extent and quality, not only can the industry be put into operation in unusually quick time, but the profits will become available at once upon the retorts being put into commission and the profits may be expected to be very considerable.

It may be that Mr. Gavin may be able to point to instances where this has in the past been the case, but such conditions have resulted from the attempted operations of works that were ill planned and not well thought out. Plants constructed under such conditions were from the first doomed to disaster.

Plants of small throughput cannot be economically operated. A plant to be capable of being economically operated must be so designed that it can be kept in

commission twenty-four fours per day, seven days per week and 365 days per year, or as near this as may be possible. Such a plant must have a staff of experts, competent to at once attend to any difficulties that may arise. Only works with a large throughput can afford to pay the salaries of such a staff.

A plant of 2,000 tons shale per twenty-four hours throughput is the ideal size for most economical operations. Such a plant when properly designed and constructed can be operated at an absurdly low cost per ton as regards wages, as is evident from the following: Taking wages at the average of the high rate of $6 per man per eight hours, the cost of mining and assembling being excluded, but including crushing, retorting, condensing, attendance in boiler and power house and for spent shale and oil delivery, including also foremen, the total number of men employed per day is but fifty-three. This, at $6, gives an expenditure of $318 for 2,000 tons throughput, or about 16c. per ton. The cost of management, chemists and office will require 8c. per ton more, or a total of 24c. per ton. The cost of ammonium sulphate recovery is a varying charge dependent upon the cost of sulphuric acid and upon the yield of the manufactured chemical per ton shale. The cost may be less than 9c. per ton shale or might be more than 20c.

Repairs may be taken as costing 3c. per ton, loss on packages as 2c. per ton, depreciation as 10c. per ton, taxes (not including excess profits tax), insurance and sundries 5c. per ton, making a total of 44c. per ton plus the cost of ammonium sulphate recovery and the cost of mining and assembling.

As previously shown the cost of mining and assembling depends upon local conditions. It may be less than 20c. per ton and it may exceed $3 per ton. Speaking generally, the whole cost per ton, including mining and ammonium sulphate recovery, may be less than $1 per ton, while on the other hand, in extreme cases, the cost may exceed $3 per ton.

As has been already stated, the difference between the cost of operating an ideally located and developed works, retorting shale in an ideally planned and constructed works and one that is not ideally placed, planned or constructed is a handsome profit in itself, and one that would afford the payment of large dividends.

Lack of Experienced Oil-Shale Engineers

There is, however, another reason why capitalists have, in the past, looked with small favor upon oil-shale propositions. Capitalists who deal largely in mining properties are accustomed to employ certain chosen engineers who are called upon to report upon any proposition submitted to them. Until within a comparatively recent rate there have been no engineers on this continent who were capable of correctly making a report upon an oil-shale property. Even today their number is limited. An engineer with a reputation and experience in gold, silver, copper or iron mining is probably about the most unsuitable man to choose to make such a report. To ask a man who has, and justly has, a reputation gained in work he understands to risk that reputation by giving opinions on work he does not understand is not fair, and such men usually find it safer to turn the proposition down. In consequence of the lack of knowledge difficulties are magnified and reasonable possibilities are ignored. It is but human nature to listen to the old adage and "When in doubt, don't."

An oil journal lately published an account of a small retort plant which operated for sixteen hours per day only, "taking advantage of daylight hours," it was stated. The result was as follows:

	Cents per Ton
Mining (open pit) and delivering	73 00
Crushing	4 50
Power, wages and gasoline	12 00
Retorting	24 00
Lubricating oil	0 25
	113 75

It is to be noted that in the above-presumed cost many charges are omitted. The figures are quoted for the purpose of comparing the cost of a small plant with one operating upon an economical throughput.

	Small Plant, Cents per Ton	Plant of Economical Size, Cents per Ton
Mining	73	20
Crushing	4½	2
Power	12	3
Retorting	24	4
	113½	29

It is certain that up to date the new business of retorting oil shales on the American continent has never had a fair chance. It is certain that it never will have a fair chance until some strong group of capitalists becomes prepared to risk capital in the construction of a plant large enough to retort 2,000 tons of shale in twenty-four hours. If such a plant be built from properly designed and thought out plans it will be proved that when operating upon medium- to high-grade shales, the return will be very much larger than "conservative" and with this additional advantage the return will be assured for many years to come.

Costs of the Industry

The costs of the industry should be made out somewhat as follows:

1. Removal of overburden or—in case of mining—preliminary work.
2. Drilling and explosives.
3. Excavating and assembling or loading and assembling.
4. Crushing.
5. Retorting and condensing.
6. Power plant, etc.
7. Removal of spent shale.
8. Byproducts recovery.
9. Warehouse and delivery.
10. Gasoline and lubricants.
11. Repairs.
12. Loss on packages.
13. Taxes, insurance and sundries.
14. Management.
15. Depreciation.
16. Amortization.

In a great many cases the cash returns from the sale of the manufactured byproducts will pay not alone the cost of such manufacture but also all the costs of mining and retorting, etc. In all cases it is necessary that the question of byproduct recovery should be examined carefully. This question has already been discussed at length in Chem. & Met. Eng., vol. 22, p. 20, Jan. 7, 1920.

When the whole cost of mining, of retorting and of recovering and manufacturing the byproducts can be paid for out of the sales of those byproducts, who is there that will dare maintain that the production of oil by retorting oil-yielding shales is not profitable or at the best will only yield "conservative" returns?

Ottawa, Canada.

Fuel Symposium at the Sixtieth A.C.S. Meeting, Chicago

TWELVE papers were presented in the form of Fuel Symposium which had been prepared by a committee of the Division of Industrial and Engineering Chemistry under the chairmanship of A. C. FIELDNER. Four major topics were discussed by the various speakers: (1) Carbonization of coal. (2) Liquid fuel problems, particularly gasoline. (3) The general problem of fuel conservation. (4) The problem of sulphur in fuels. This session aroused a great deal of interest because of the widespread attention being given to fuel matters and urgency of fuel supply in industry at the present time.

CARBONIZATION OF LIGNITE

A paper entitled "Carbonization of Canadian Lignites," by EDWARD STANSFIELD, was presented by Mr. FRENCH, the engineer who has been associated with this investigation, covering the work done jointly by the Department of Mines and the Lignite Utilization Board of Canada. This report described the early small-scale experiments and the later larger-scale tests which have led up to the design and construction in southern Saskatchewan of a plant which is expected to handle two hundred tons of raw lignite per day. The lignites used are available at about $1.75 per ton at the mine. A typical analysis of the material employed, on a moisture-free basis, is as follows: Water of constitution, 31.8 per cent, volatile, 28.9 per cent, fixed carbon, 34.1 per cent, ash, 5.2 per cent. The heating value is approximately 4,260 calories per gram. From this material the following results are reported:

	Percentage of Weight of Dry Coal	Per cent of Original Heating Value
Water	11.7	...
Gas	17.0	8.3
Crude tar	4.1	6.0
Residue (char)	66.7	78.1
Loss	0.5	7.6

These represent yields of about 3,150 cu.ft. of gas having a heating value of 385 B.t.u. per cu.ft., 5.3 gal. of tar, 910 lb. of residue, and 10.2 lb. of ammonium sulphate per ton of dry lignite treated. The process is developed to a point where the tar is distilled and the pitch from this used as a binder for briquetting the char. The principal object of this work is the development of a solid fuel, therefore less effort has been made upon gas and byproduct recovery thus far. The commercial plant is nearing completion, and it is hoped that operations will begin within a few months.

As a contribution to the discussion of this report, E. P. SCHOCH, professor of the department of chemistry of the University of Texas, presented a discussion upon the utilization of Texas lignites. The effort in this work was to obtain a supply of city gas, and the tendency was, therefore, along different lines than had been described in the Canadian work. Special attention was given to operation of the retorts under pressure. It was found that this gave a higher yield of gas, but at the expense of a lower yield of tar. This result was probably caused by the slower elimination of the vapors from the retort, causing a greater cracking and, therefore, larger gas yield from the otherwise liquid constituents.

The large percentage of carbon dioxide in the gas led to a special effort looking to the removal of this constituent. As a result liquid purification was adopted and very favorable results are reported. From 2,000 to 3,000 cu.ft. of gas per ton of raw lignite was thus obtained with a heating value in the gas approaching 600 B.t.u. per cu.ft. The yield of coke and tar were of the same order as those reported on the Canadian material.

The advantages claimed for the method of handling recommended were: Coke of a good heating value, gas immediately usable for city supply, maximum yield of tar, a cheap retort of large capacity operating under conditions that make for long life, and the production of coke easily handled in briquetting.

FUEL CONSERVATION

H. C. PORTER discussed the general subject of present and future conservation of fuel supplies. Among the means of increasing our fuel resources he suggested the following: Increased use of boiler plant accessories such as feed-water heaters, and other efficiency devices, use of gas instead of coal in steel plants; electrification of railways; development of superpower electric stations; carbonization of coal at the mine; increased carbonization with recovery of byproducts; alternate carbonization and steaming of coke in a single machine for production of a mixture of coal-gas and blue-gas; use of oxygen to enrich water-gas blast (the oxygen to be made with power used at off-peak hours); a lower heating value per foot for city gas supply; elimination of beehive ovens; and other well-recognized means of fuel economy.

The article by HENRY KREISINGER entitled "Byproduct Coke, Anthracite and Pittsburgh Coal as Fuel for House Heating" was presented by title only. Similarly the reports on "The Charcoal Methods for Gasoline Recovery" and the report on "Colloidal Fuels" were not presented in detail. The abstract of the paper on the latter subject by C. A. SHEPPARD included the following comments:

Colloidal fuels is a name given to a distinct class of liquid-to-semi-liquid blended fuels. They were developed in this country during and subsequent to the last two years of the great war. They are composites, in which finely divided carbonaceous solids or semi-solids—various kinds of coal—are so suspended in and blended with liquid fuel oils as to form readily stable and atomizing fuels. They have been developed for burning with the regular types of atomizing burners using ordinary fuel oils, but have also possibilities for use in internal combustion engines of the Diesel and semi-Diesel type.

The machinery for compounding these fuels is simple; it consists of a suitable mill for pulverizing coal, coke, etc., storage and blending tanks for the oil bases, and mixing kettles for compounding the composite fuel. Little modification in existing types of machinery is necessary, and the process is readily made continuous. The cost of manufacture may be reckoned at approximately $1.50 per ton, inclusive of the fixateur—a substance used in small quantity to stabilize the colloidal fuel.

The following is a brief summary of the properties of colloidal fuels:

1. They are liquid and handle and atomize for combustion like fuel oils.
2. They contain more heat units per gallon than fuel oils.
3. They contain very little moisture and ash.

4. The temperature at which they take fire (flash point) is above 200 deg. F. They are immune from spontaneous combustion.

5. Not only are they vaporless up to high temperatures, thus avoiding explosive mixtures with air, but they may be fireproofed by a "water seal" of an inch or more of water, owing to the fact that they are heavier than water.

6. Hence also they will sink if spilled blazing on the surface of water—i.e., they are self-quenching. Their fire risk is as low as anthracite coal, and far less than bituminous coal or ordinary fuel oil.

7. They are the most compact fuels known. The advantages of this are obvious: increased radius for ships, lessened storage space in crowded cities.

Byproduct Coking

F. W. Sperr, reviewing the byproduct coke situation, summarized the present status of work in this field. He emphasized particularly the trend toward byproduct gas manufacture and away from the production of water gas. The lesser labor requirement per ton of coal handled in byproduct ovens as compared with coal gas plants handling the coal at smaller units is also a factor at present tending to increase byproduct oven operations. The relative economy of beehive and byproduct oven operations was emphasized and the trend for many years past toward byproduct coke for blast-furnace use was pointed out. It was urged that further study should be given to additional applications of coke so that more of our bituminous coal could be handled with byproduct recovery. Utilization of coke breeze by stokers was pointed out as one important contributing factor to the success of coking at the present time. Other factors mentioned were producer gas firing of ovens, use of silica refractories in place of fireclay materials, the extensive application of tar as a metallurgical fuel, etc. It was pointed out that recent byproduct ovens provided for steaming of coke in the oven, thus arranging that almost complete gasification of the solid fuel may be accomplished in what is practically a single operation.

Low-Temperature Carbonization

S. W. Parr presented a discussion of low-temperature carbonization, by which he meant treatment of fuel at temperatures below 750 to 800 deg. C. He indicated that up to this temperature he considered essentially only primary products of distillation; secondary products of high-temperature decomposition do not enter materially until higher temperatures are reached. The usual method of rating coals as to cokability depending upon the ratio of oxygen content to hydrogen content is criticized by this author. He pointed out that conditions of treatment of the coal were of greater importance than this ratio, for if temperature is properly controlled the interaction of the oxygen compounds with those compounds which afford the binder for the coke is prevented. He presented one example of a coal badly weathered which was still suitable for coke production by proper temperature control. He advanced the theory that those constituents which are soluble in phenol react upon heating with oxygen compounds to give compounds of variable composition and prevent coking. He emphasized particularly that the sulphur, nitrogen, and oxygen compounds formed seemed to violate the laws of definite compounds as the percentage composition of these compounds varied by small steps, in a way inconsistent with our usual concept of definite composition.

Because of the low heat conductivity of the coke mass through which heat must be transferred by ordinary systems of coking, this author has undertaken to use the exothermic heat of reaction during coal carbonization to furnish the bulk of the heat required for coking. He refers to the reactions thus as proceeding "autogenously." He expresses two of his conclusions in this particular as follows:

"It is possible to utilize the exothermic reactions inherent in high oxygen coals in such a manner as to secure the autogenous transmission of heat to the center of an otherwise non-conducting mass and under conditions wherein the ultimate temperature attained at any point of the coal mass is not in excess of the prescribed limit.

"The time for autogenous transmission is governed by the speed of the exothermic reactions involved and is estimated to be approximately one-fourth of the time required for heat penetration as obtained under high-temperature conditions."

At the present time Dr. Parr has not proposed any definite industrial processes, but is working on a basis of a discontinuous operation with 35 lb. samples—i.e. on a commercial laboratory scale.

Gasoline Losses

A. C. Fieldner and associates reported upon extensive tests of motor vehicles for efficiency in gasoline use. These tests make clear the very large losses of gasoline which result from improper carburetor adjustment and careless driving. These tests were those carried out in connection with the investigation of poisonous gases from automobile exhaust which must be cared for in the proposed vehicle tunnel under the Hudson River.

Mixture of Natural and Manufactured Gas

J. B. Garner urged the use of natural gas for the enrichment of manufactured gas supplies, stating that in his opinion natural gas companies should no longer be permitted to sell natural gas as such but should conserve it for the city supply to supplement the manufactured gas production for these purposes.

Commercial Realization of Low-Temperature Carbonization

Dr. Harry A. Curtis, chief chemist of the International Coal Products Corporation, reported on the Carbocoal process, which has been developed to the point of the installation of a plant having a daily capacity of 350 tons of product, using 500 tons of coal per day. This process was described in Chem. & Met. Eng., vol. 23, No. 10, Sept. 8, 1920, p. 499.

Sulphur in Fuels

The report of Alfred R. Powell discussed the factors which affect the sulphur content of coke and of gas produced by the carbonization of bituminous coals. The significance of the different sulphur compounds in the coal upon the distribution of the sulphur in the products is pointed out.

A report on a similar subject was presented by H. F. Yancy and Thomas Fraser, entitled "The Distribution of the Forms of Sulphur in the Coal Bed." The relations between the relative quantities of pyrite sulphur and organic sulphur were discussed. This work represents a report on a large number of mine samples, particularly those collected in southern Illinois and western Kentucky.

Dr. Allen Rogers Receives the Grasselli Medal

AT THE joint meeting of the American Section of the Society of Chemical Industry and the New York Section of the Société de Chimie Industrielle, Friday evening, Oct. 8, the Grasselli Medal was presented to Dr. Allen Rogers of Pratt Institute.

Presentation Address

BY MARSTON TAYLOR BOGERT

The Grasselli Medal was established by the Grasselli Chemical Co. of Cleveland, Ohio, to be awarded annually for the paper presented before the New York Section of the Society of Chemical Industry which shall, in the opinion of the medal committee, offer the most useful suggestions in applied chemistry. The committee of award, at its meeting Sept. 17, 1920, voted unanimously to bestow the medal for this year upon the honorary secretary of the American Section, Dr. Allen Rogers, for his paper entitled "Industrial Uses for the Shark and Porpoise," printed in the *Journal* of this society for Jan. 31, 1920 (vol. 39, No. 2, pp. 9-10T).

DR. ALLEN ROGERS

As a personal friend both of the donors and of the recipient of the medal, it will be understood how pleasant I find my task this evening as the official to make the formal presentation.

Dr. Rogers was born in Hampden, Me., May 22, 1876, and was graduated from the University of Maine in 1897 with the degree of B.S. in the chemistry course.

In 1900 he received the degree of M.S. from his alma mater and in 1902 the degree of Ph.D. from the University of Pennsylvania, where he remained for two years as senior fellow and instructor in organic chemistry.

In June, 1904, he abandoned this temporarily, to enter the employ of the Oakes Manufacturing Co., Long Island City, N. Y., as research chemist, where his investigations on problems related to the leather industry led to several patents being taken out by the company.

In September, 1905, he withdrew from the Oakes Manufacturing Co. and returned to the ranks of the teachers, as professor in charge of industrial chemistry at Pratt Institute, Brooklyn, N. Y., the position he still occupies.

For many years Dr. Rogers has made a special study of leathers and tanning, until he is now widely recognized as one of our foremost experts in this important field. Patents have been granted to him for various processes of treating leather, and other patents are pending. His most interesting work in this direction is that recorded in the paper for which the medal is awarded.

In the time of our country's need he promptly and patriotically sacrificed all personal selfish interests and volunteered for military duty, being commissioned Major in the Chemical Warfare Service, where he was put in charge of the industrial relations branch.

Dr. Rogers is the author of a Manual of Industrial Chemistry, in preparation of which he was aided by over forty distinguished collaborators.

It therefore gives your host of friends particular pleasure, Major, to see this medal awarded to one who has for so many years labored so unselfishly for others and who has devoted himself so assiduously and so successfully to the development of that branch of chemical industry to which the paper relates. May it bring to you much happiness, and may it prove an inspiration to yet further achievement!

Acceptance of the Grasselli Medal

BY ALLEN ROGERS

My dear Colonel Bogert: I certainly appreciate your kind words and hope that I may be worthy of all the good things you have said. It was a great surprise to me, I assure you, when I received the information that my paper on "Industrial Uses for the Shark and Porpoise" had been deemed of sufficient merit to warrant recognition for the award of the Grasselli Medal. The commercial utilization of the shark is a matter that has interested me for several years, and if I have done anything to interest others in my friends of the deep, it is of course very gratifying. Sharks have always been considered as scavengers and of no benefit to man. My work, however, has shown me that they have some good points in their favor, and if we take advantage of them I feel confident that a great industry may eventually be established. Already much has been accomplished in this direction. A fairly large plant is in operation at Morehead City, N. C., where the fish are caught, the skins removed, the livers rendered for oil and the flesh converted into fertilizer stock. Another plant is located at Sanibal Island, Fla., and at the tannery in Newark, N. J., about one thousand skins are being treated each week. Plans are now under way for establishing other stations at various points along the Atlantic and Pacific coasts, while the existing plants will be greatly enlarged.

As time goes on and we learn more about these despised creatures we will no doubt discover new uses for the various parts of their anatomy, and who can tell what benefit may then be derived?

I am sorry not to have been able to show some new motion pictures recently taken at the various plants, but hope to do so in the near future. At that time I may have some results of investigation to present. I have, however, a few samples of leather and oil and will be glad to answer any questions after the meeting.

In accepting this medal I wish to thank the Grasselli Chemical Co., through whose generosity the award is made possible. I desire to express my appreciation to the members of the medal committee for their consideration, and I want to thank you personally for the friendship you have manifested and the inspiration you have given to me in making the presentation of this beautiful medal.

Synopsis of Recent Chemical & Metallurgical Literature

Manufacturing Pig Iron From Pyrites Cinders in Electric Furnaces.—In the manufacture of sulphuric acid from pyrites a byproduct rich in iron is obtained which up to now is of very little use due to its high content of sulphur, making it unfit for use in the blast furnace as an iron ore. MARCEL GUÉDRAS gives a description of manufacturing pig iron from pyrite cinders in electric furnaces in the July, 1920, issue of *Technique Moderne*, pp. 301-304, of which the following is an abstract:

The average composition of the pyrites cinders is:

	Per Cent
SiO_2	3
Fe_2O_3 (66 per cent iron)	94
S	2.75 to 3.5

This is evidently a very rich ore if it could be used. In collaboration with M. Duina, the author has devised a process for the manufacture of pig iron from cinder in the electric furnace.

In the blast furnace the use of pyrites is limited to a maximum of 10 per cent of the charge. It has been possible to increase this percentage after scorifying by a German process which consumes a relatively great amount of fine coke or coal, but the porous cinders obtained still contain 0.5 to 0.45 per cent sulphur.

A more rational process for treatment is by reduction in the electric furnace, a practical and advantageous process when considering the richness of the cinders in iron and the small content of silica.

A very important point, which formerly has not been duly considered by metallurgists, is the physical state of the roasted pyrite. This pulverulent material is spongy and by this fact absorbs great quantities of water. Quite often pyrite cinders after standing some time contain as high as 20 to 22 per cent of moisture.

To obtain a normal and regular treatment of pyrite cinders it is absolutely necessary first to dehydrate them completely, combining this operation with a partial desulphuration; to be later completed by chemical reactions in the reduction furnace. This point constitutes one of the principal specifications of the Guédras-Duina process.

Desulphuration and dehydration is to be followed by agglomeration, since it is necessary that the cinders shall not be charged into the electric furnace in a pulverulent state, as the fine material would sift through the other constituents of the charge, partially escape reduction and, therefore, be lost with the slag. The combined operations of dehydration, desulphuration and agglomeration take place in a gas heated rotary Breuillé kiln. Temperature required is from 1,000 to 1,200 deg. C.

Pyrite cinders with a sulphur content of 2 to 3 per cent when charged into the furnace leave the furnace with a sulphur content of 0.1 to 0.2 per cent; the nodules are strong, but highly permeable to gases, a very useful quality for the subsequent reducing operation.

Reduction takes place in an open top electric furnace, but can also be done in an electric blast furnace when the gases are to be used.

The desulphurating reactions which take place during reduction are:

(*a*) A reaction which is proper to all electric furnaces—namely, the action of lime carbon with the formation of calcium carbide. Carbide and lime then react with iron sulphides thus:

$$3FeS + 2CaO + CaC_2 = 3Fe + 3CaS + 2CO$$

(*b*) Calcium chloride is also added to the charge, and it intensifies the desulphuration of the molten bath as given by the equation

$$FeS + CaCl_2 + CO = Fe + CaS + COCl_2$$

When the formed carbonyl chloride comes in contact with moisture in the furnace atmosphere or after escaping to the air it is rapidly destroyed according to the equation

$$COCl_2 + H_2O = 2HCl + CO_2$$

(*c*) Adding manganiferous minerals or manganiferous slag to the charge for the introduction of manganese into the pig iron is also of help in desulphurization.

The technique of this process is based upon two distinct ideas:

(1) Absolute necessity to eliminate the moisture completely in a preliminary roast.

(2) Utilization of the desulphurizing action of the electric furnace, which action is increased by the presence of a calculated amount of calcium chloride in the molten bath.

Due to the high content of sulphur in the original material it is practically impossible to have a complete desulphuration by chemical processes only and it is therefore necessary to have a preliminary desulphuration in conjunction with the dehydration.

Calcium sulphide formed in the furnace is very unstable. This instability is correlated to the question of molecular equilibrium between the constituents of the slag.

The miscibility of sulphur in the metal depends upon the concentration of sulphide in the slag and on the tension of the sulphur.

Very little research has been done upon the vapor pressure of sulphur in hot sulphides, and the data reported usually present great discrepancies. A fact well determined is that when a certain quantity of sulphur has passed into the state of calcium sulphide the equilibrium ratio between iron sulphide in the slag and that in the metallic bath is changed and a certain quantity of sulphur passes into the slag. This action is much more pronounced in continuous pig-iron furnaces than in electric-steel furnaces, due to the continuous addition of the slag-forming lime.

The rôle of carbon oxychloride is of great importance. This is best shown by Michalske's reaction, which takes place even in molten baths:

$$CaO + CaCl_2 + 4C + 2CO = 2CaC + COCl_2 + CO_2$$

Chlorine in the $COCl_2$ thus formed displaces sulphur in iron sulphide

$$2COCl_2 + 2FeS = 2FeCl_2 + 2S + 2CO$$

or

$$3COCl_2 + 2FeS = 2FeCl_2 + 2S + 3CO$$

The advantages of elimination of sulphur by substitution are that the limit of CaS saturation in the slag cannot be exceeded and complete desulphurization of the metallic bath can be realized.

A desirable slag would be calculated to correspond to the formula $SiO_2.2CaO$—i.e., a basic silicate, in which

will be found a certain quantity of CaC_2, considered in itself a very basic substance. However, to lower the melting point of the slag it is advisable to incorporate a certain proportion of alumina and thus figure to an alumino-calcic silicate of the formula $SiO_2 . Al_2O_3 . 2CaO$.

The reducing agent used may be coke, charcoal or a mixture of charcoal and anthracite.

To produce a ton of pig iron 380 to 400 kg. of coke is required, which corresponds to 218 kg. of carbon, plus what is needed for carburation.

The consumption of energy may be tabulated as follows:

				Calories
Reduction of	930 kg. iron	×	1,887	1,754,910
Reduction of	10 kg. Si	×	7,830	78,300
Reduction of	5 kg. Mn	×	1,730	8,650
Vaporization of	165 kg. H_2O	×	1 549	255,585
Fusion of	1,000 kg. pig iron	×	300	300,000
Fusion of	400 kg. slag	×	500	200,000
Total heat spent				2,597,445
Heat received:				
Combustion of 212 kg. of carbon × 8,133				1,724,196
				873,249
Losses by cooling and radiation				259,744
Heat to be furnished by the current				1,132,993

That is to say, 1,322 kw.-hr. The actual consumption is on the average 2,200 kw.-hr.; the furnace has, therefore, a power factor of 0.6, which is low.

Pig iron obtained by this process analyzes 0.001 to 0.03 per cent sulphur, which of course is excellent. The consumption of electrodes is 14 kg. per ton of pig iron produced. An industrial plant of 3,000 kw. can produce 11,000 tons of pig iron per year and requires 16,060 tons of pyrite cinders.

Recent Chemical & Metallurgical Patents

British Patents

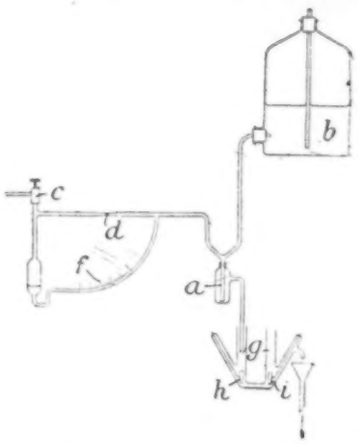
Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Hardening Iron and Steel.—An aniline dyestuff such as auramine and methyl violet is used in hardening wrought iron and steel. The material in powdered form may be mixed with rock salt, saltpeter and carbon, etc., and spread over the article to be hardened; or a solution in ammonia water may be used for quenching. (Br. Pat. 143,510—1919. W. KAISER, Frankfurt-on-Main, July 21, 1920.)

Sulphonic Esters.—Resinous compounds are prepared by the reaction of phenolalcohols with aromatic sulphochlorides containing hydroxy or carboxylic groups or both these groups; mixtures of two or more such sulphochlorides may be used; the reaction is effected in presence of alkali, preferably in slight excess. The products can be converted into soap-like products which can be used as emulsifying agents, or in the manufacture of lubricants from tar oils. Br. Pat. 143,185—1919. See also 143,187—1919. B. MELAMID, Breslau, Germany, July 21, 1920.)

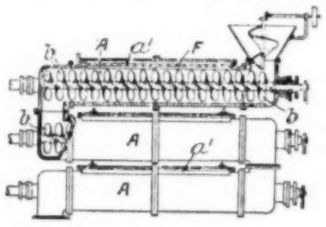
Transformer Oils.—Tar oils dissolved or not in an inactive solvent are oxidized as by bichromate or permanganate mixtures at low temperatures to obtain fluid oils capable of use as transformer oils. In an example 100 kilos tar oil is stirred for about an hour with bichromate mixture, and allowed to stand until atmospheric temperature is reached. The supernatant oil is separated from the resin deposited, refined with 2 to 3 per cent of 66 per cent sulphuric acid, washed, and distilled *in vacuo*. In a second example, 100 kilos tar oil is dissolved in 100 kilos benzine and treated at 0 to 5 deg. C.; the solvent is distilled off, and the oil treated as in the first example. (Br. Pat. 143,193—1919. M. MELAMID, Breslau, Germany, July 21, 1920.)

Synthetic Ammonia Analysis.—In the synthetic production of ammonia, the gases circulating in the system are, for determining their ammonia content, passed through an absorbent of ammonia and the electrical



conductivity of the resulting solution measured. In a suitable apparatus, the gases pass through a regulating-valve *c* and a flow-meter *d*, *f* to an absorber *a* supplied with water at a predetermined rate from a vessel *b*; the solution then passes into an electrolytic cell *g* having electrodes *h*, *i* of platinum, etc., and in circuit with suitable apparatus for measuring the conductivity. (Br. Pat. 143,341—1919. E. K. RIDEAL and A. G. TARRANT, University College, London, July 21, 1920.)

Glucose.—One part of wood is first dried, treated with 1 to 2 parts of 35 per cent hydrochloric acid, and supersaturated with gaseous hydrochloric acid until the acid concentration reaches 41 per cent, the temperature being maintained between 0 and 25 deg. C. It is then allowed to digest at a slightly higher temperature, and finally the surplus acid is removed and the glucose purified by washing and filtration. The acid treatment is conducted in a series of externally-cooled connected tubes *A*, each provided with a mixer and conveyor *b*, liquid acid being introduced into the upper vessel and gaseous acid into the lower vessels through pipes *F*. The mash is digested for two to eight hours in drums adapted to turn on hollow axes, through which water is circulated so that the temperature is maintained between 3 and 30 deg. C. Excess hydrochloric acid is then withdrawn from the mass, which contains a mixture of glucose and dextrin, by placing the drum in communication with a vacuum vessel containing dilute acid kept at 10 to 15 deg. C. Sufficient water is added to the mash to allow it to be filtered, and the filtrate is concentrated *in vacuo* to free it entirely from hydrochloric acid, which is collected in



the usual manner. The dextrin may be converted into glucose by boiling for about an hour with diluted hydrochloric acid. Specification 107,219 is referred to. (Br. Pat. 143,212—1919. L. TERRISSE and M. LEVY, Geneva, July 21, 1920.)

Treating Hides and Skins, Electric Endosmose.—In tanning or impregnating materials, they are first impregnated with the tanning, etc., liquor by electric endosmose, and are then treated with preferably stronger liquor without electric current, to complete the tanning, etc. The electric treatment may be carried out as described in Specification 19,849—1914, with liquor of density 2 to 3 Bé., and may last 2 to 3 hours. The non-electric treatment may be effected with liquor of density 10 deg. Bé., and its duration may be two days. Suitable tanning material is extract of pine bark, oak, or chestnut. The invention is applicable to the impregnation, with chromium or other metal salts or colloids, of fabrics which have been treated with glue or gelatine. (Br. Pat. 143,921—1919. ELEKTRO-OSMOSE AKT. GES., Berlin, Aug. 5, 1920.)

Copper Sulphate.—Copper sulphate is obtained from raw copper carbonate ore by treating with dilute sulphuric acid until the solution becomes sufficiently rich in copper, and then neutralizing the solution by some untreated copper carbonate ore, and heating to boiling point until its density is about 52 deg. Tw., it being meanwhile maintained in basic or neutral condition, for which purpose copper oxide may be added and air or steam may be forced through the solution to facilitate separation of the precipitated impurities on cooling. The precipitated matter is separated, and, if any impurities remain, the solution may be again boiled and cooled. (Br. Pat. 143,973—1919. J. S. ROSS, Westminster, Aug. 5, 1920.)

Purifying Rock Salt.—Rock salt is purified for table use by first comminuting it into grains of about 1 mm. in size and sifting, and then grading the grains in saturated salt solution according to their specific gravity. By the process of comminution, the more brittle impurities, such as anhydrite, are broken down into fine powder, which is sifted away; while in the grading treatment, the heavier particles, such as the sulphates of calcium and magnesium, collect in the lower part of the grading device and the pure salt in the upper part. The grading devices are of the kind in which an inclined sieve is agitated in salt solution, or in which the comminuted salt is moved against the flow of strong brine. (Br. Pat. 144,022—1919. L. W. DAMMAN, Zwolle, Holland, Aug. 5, 1920.)

Treating Yarns and Fabrics.—Cotton yarn or cloth is treated for rendering the surface thereof smooth, lustrous, soft, suitable for dyeing and incombustible. The material is immersed for from one to fifty minutes in sulphuric acid of 52 to 60 deg. Bé., washed in water, shaken, beaten or stretched to remove adhering or projecting fibers, and immersed for ten to fifteen minutes in caustic soda having a specific gravity of from 8 to 15 deg. Bé. It is then treated with a 3 per cent solution of borax to render the material incombustible, and afterward with a 5 per cent solution of glycerine or with a solution of calcium chloride, glucose or soap. (Br. Pat. 144,083—1920. S. KASHITANI, Osaka-fu, Japan, Aug. 5, 1920.)

Purifying Oils and Fats.—Animal and vegetable oils and fats, such as whale oil and maize oil, are freed from fatty acids so as to give directly and quantitatively a neutral oil or fat free from soap and a dry alkali soap ready for use, by treatment with dry caustic alkali or calcined alkali carbonate and removal of the water produced by the reaction, as by heat and agitation under reduced pressure or by the addition of calcined sodium sulphate, and taking up the oil in dry solvents such as methylal, ether, methyl acetate, acetone and carbon disulphide, that dissolve only the oil. The solvent may be added at the start or after removal of the water formed. Thorough bleaching of the oil or fat and the soap may be effected by using peroxide or percarbonate in place of caustic alkali or carbonate. (Br. Pat. 144,176—1919. A. G. BLOXAM, London, Aug. 5, 1920.)

Obtaining Textile Fibers From Papyrus.—In the preparation of textile fibers, which may be used as a substitute for hair, from papyrus, the material, after soaking or retting, is subjected to slight mechanical pressure and to an alternating simultaneous right and left hand torsional or twisting movement, in pairs of rollers so arranged that adjacent pairs move axially in opposite directions. The fibers are dried and the loosened incrusting material is removed and may be used as a carrier for the exciters in the fermentation process. To obtain a cleaner fiber, the fibrous material, either before or after the mechanical treatment, may be subjected to a short fermentation. (Br. Pat. 144,249—1919. J. J. GAHLER HERISAU, Appenzell, Switzerland, Aug. 5, 1920.

Triphenylmethane Dyes. — Triphenylmethane dyes are obtained either by condensing sulphonated aromatic aldehydes with *o*-nitraniline or derivatives thereof having a free *p*-position, or by condensing unsulphonated aromatic aldehydes with *o*-nitraniline or derivatives thereof having a free *p*-position and sulphonating the product. In the second case, the condensation product is a mixture of the product from one molecular part of aldehyde and two molecular parts of *o*-nitraniline with other products which probably result from further reaction of the aldehyde; the crude mixture can be sulphonated or can be separated into its constituents—e.g., by means of hydrochloric acid—before sulphonation. According to examples: benzaldehyde is condensed with *o*-nitraniline and the product is sulphonated, or the product is separated into its constituents by hydrochloric acid, and the separated constituents sulphonated; benzaldehyde *m*-sulphonic acid is condensed with 3-chlor-6-nitraniline. The products dye wool yellow shades. (Br. Pat. 144,658—1919. BADISCHE ANILIN UND SODA-FABRIK, Ludwigshafen-on-Rhine, Aug. 11, 1920.)

Ammonium Chloride; Alkali Manufacture. — Synthetic ammonia is used in the ammonia-soda process, and the ammonium chloride liquor produced is not treated for the production of ammonia, but is evaporated to obtain a separation of sodium chloride at a high temperature, such as 100 deg. C., and then cooled to obtain a separation of ammonium chloride at a low temperature, the heating and cooling to obtain these salts being repeated if desired. The final mother-liquor, which is a cold solution saturated with ammonium and sodium chlorides, may be added to the liquor to be treated for the production of ammonium and sodium chlorides as above described. It is stated that it is advantageous to oxidize a portion of the synthetic ammonia to nitric acid and to use some of the bicarbonate of soda obtained from it to absorb the acid. (Br. Pat. 144,659—1919. BADISCHE ANILIN UND SODA-FABRIC, Ludwigshafen-on-Rhine, Aug. 11, 1920.)

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Process for Treating Complex Zinc Ores. — The treatment of complex ores containing both volatile and non-volatile constituents, such as lead-zinc ores with which are associated copper and precious metals, is a difficult metallurgical problem. Both wet methods of treatment and smelting methods have been proposed. When smelting lead ores containing zinc in a blast furnace it has been necessary to keep the zinc content of the slag below 8 per cent as a maximum and this, together with the building up of zinc oxide accretions in the cooler portions of the furnace shaft when treating ores high in zinc, has limited the zinc content of the charge to about 7 per cent.

L. B. SKINNER of Denver, Col., proposes to treat this type of ore in a reverberatory furnace in such a way that a greater portion of the zinc is volatilized from the charge and subsequently recovered as fume. Ores high in zinc can thus be treated without difficulty. The method consists in preparing a mixture of an oxidized siliceous ore containing iron and sulphur to form a matte from the non-volatile constituents of the ore with an excess of solid carbonaceous material over that necessary to effect the possible reductions of the charge and treating this mixture on the hearth of a reverberatory furnace by the combustion of fuel with a moderate excess of preheated air. The volatile constituents of the ore are reduced *in situ* by the reducing agent and the gaseous products are passed through a regenerative stove to preheat the air used for the combustion of the fuel and the fume recovered in a bag house. (1,350,286; Aug. 17, 1920.)

Process for the Extraction of Lead From Its Ores. —Several methods have been suggested for the hydrometallurgical treatment of ores for the recovery of lead and silver, and that more generally termed the "brine process," or "acid brine process," has been used on ores, concentrates and for the recovery of lead and silver from electrolytic zinc plant residues.

F. E. ELMORE of Boxmore, England, has been granted a patent on a modification of the "brine process" which has for its object the economical use of reagents. In some ores lead occurs as a sulphate or can be converted into a sulphate by roasting and in this form can be separated from gangue material by leaching with a hot brine solution. If the lead occurs as sulphide a hot brine acidulated with sulphuric acid will produce a solution containing the lead. Under either condition a certain amount of sodium sulphate and sodium acid sulphate is produced, and the solution becomes, on repeated use, less efficient due to the accumulation of sodium sulphate and to the depletion of the sodium chloride. Further, lead salts are produced containing varying proportions of the sulphate and chloride which under certain conditions is a disadvantage. The proposed process consists in the crystallization and separation of the lead salts from the leach solution and then crystallizing sodium sulphate from the lead-free solution by further cooling to about zero deg. C. The sodium sulphate is separated from the brine and dissolved in hot water. This sodium sulphate solution is used at about 100 deg. C. to treat the lead salts obtained from the first crystallization and thus change the lead chloride to sulphate with the regeneration of sodium chloride. The lead sulphate is separated from this solution also by crystallization. It is possible to obtain a lead sulphate practically free from chlorides by control of the operation. In case the lead salts contain silver, these after separation from the brine are boiled with sufficient water to dissolve the lead chloride; an insoluble residue remains containing practically the whole of the silver. The lead chloride solution is separated from the residue and treated with hot sodium sulphate solution for conversion into lead sulphate. (1,350,959; Aug. 24, 1920.)

Ammonium Sulphate.—A simplified procedure for the recovery of ammonia from coke-oven gas has been devised by BATES TORREY, Jr., of Syracuse, N. Y. The hot gases are sprayed with water in the hydraulic main and the hot water thus obtained is separated from the tar in settling tanks. The gases are further cooled in a scrubber and the residual tar is removed in a tar extractor. The gases now pass through another scrubber which is sprayed with the hot water recovered from the hydraulic main. During this treatment the gases take up the free ammonia in the wash water and carry it along to the saturators. The unvaporized water from the scrubber is pumped back to the hydraulic main to be used in spraying the raw gas. After a time, due to the repeated circulation of the water, the concentration of fixed ammonium salts in the solution approaches saturation. Provision is therefore made for the periodical removal of a portion of the concentrated solution. This is treated with lime in an ammonia still. The liberated ammonia passes to the saturators. (1,349,393; assigned to the Semet-Solvay Co.; Aug. 10, 1920.)

Purifying Magnesium Compounds.—Magnesium oxide may be separated from many impurities by treating with a boiling solution of ammonium sulphate. Magnesium sulphate is formed, with the liberation of ammonia, which, when passed into a cold solution of $MgSO_4$, precipitates an equivalent amount of magnesium hydroxide. The reaction is thus cyclic.

$$MgO + (NH_4)_2SO_4 + aq. = MgSO_4 + 2NH_3 + aq. \quad \text{(Hot)}$$

$$MgSO_4 + 2NH_3 + aq. = Mg(OH)_2 + (NH_4)_2SO_4 + aq. \quad \text{(Cold)}$$

The reaction may also be applied to magnesium carbonate, in which case ammonium carbonate is liberated and the final precipitate is a basic carbonate of magnesium. (1,348,933; CLINTON E. DOLBEAR of San Francisco, Cal.; Aug. 10, 1920.)

Treating Waste Pickling Solutions.—Waste pickle liquor (from sheet, plate or wire mills) is forced through spray nozzles into a furnace so heated that the temperature at the top is about 1,200 deg. F., while at the bottom it is about 1,500 deg. F. The vapors, which result from the evaporation of the solution and the decomposition of the ferrous sulphate, pass over a catalyzer which converts any SO_2 to SO_3. They are then condensed in the form of sulphuric. The iron oxide deposited in the furnace is in an extremely fine state of subdivision and hence is of unusual value as a pigment or filler. (1,348,462; ALBERT T. WEAVER of Joliet, ERNEST W. D. LAUFER of Arlington Heights, and EBERHARD VON WINTZINGERODE of Chicago, Ill., assignors to the American Steel & Wire Co.; Aug. 3, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Meeting of the Rochester Section, A. C. S.

Saturday afternoon, Oct. 2, the Rochester Section of the A. C. S. held its first meeting of the year. The event was celebrated by a visit to the New York State Agricultural Experiment Station at Geneva. Here about one hundred chemists from Rochester, together with those of Geneva, listened to a very interesting address by Dr. L. L. Van Slyke, head of the chemistry department of the station.

Dr. Van Slyke gave a résumé of the work of the station, which consisted largely in its early days of routine analysis, but which has since been enlarged in its scope to cover investigation in milk and milk products, animal nutrition, plant foods, soils, fertilizers, insecticides, etc. Special inspection and research work on milk and its products has resulted in bringing this industry to a very much more efficient and higher plane. The first work in chemistry at the Geneva experiment station was carried on by Dr. Stephen M. Babcock, who is now director emeritus of the Wisconsin Experiment Station. The name Babcock is familiar to agricultural chemists the world over. The name Van Slyke is equally well known.

After Dr. Van Slyke's address Richard F. Keeler presented an outline of a method proposed by Dr. Hobart H. Willard and himself for the determination of aluminum in the presence of a relatively large amount of magnesium by measuring the hydrogen ion concentration. He gave a description and demonstration of an apparatus designed for a plant control laboratory by the use of which the amount of aluminum in from four to six samples of magnesium aluminum alloy can be determined definitely by one operator in less than an hour.

An inspection of the laboratories and farms, followed by a dinner at Hotel Seneca, at which there were talks by Dr. L. L. Van Slyke, Dr. R. J. Anderson, Dr. C. E. Kenneth and Byron Grimes completed the day's program.

Industrial Cost Association Meets in New York

The Industrial Cost Association, the object of which is "the standardization of accounting and cost terminology; . . . interchange of average experience between representatives of manufacturers and dealers engaged in similar activities; . . . to act as a clearing house in distributing to all members the development in cost practices to the end that uniformity, once established, may be maintained," held a meeting in New York City, Sept. 27. This organization is one of industrial executives rather than of professional cost accountants. Membership is held by representatives of a wide range of industries, including many which may be classified as chemical and metallurgical. The officers of the organization are M. F. Simmons, of the General Electric Co., president; C. H. Smith, of the Westinghouse Air Brake Co., first vice-president; Roland H. Zinn, of the Tanners' Council, second vice-president, and A. A. Alles, Jr., of the Fawcus Machine Co., secretary-treasurer. These officers, with the following, comprise the directors: Walter Rantenstrauch, Spencer M. Duty, W. H. Moore, W. E. Hundley and G. K. Wilson.

Evaporation Losses in Gasoline

While engineers, chemists and automobile men throughout the country have been bending their best efforts toward developing some liquid fuel as a substitute for gasoline to meet the ever-increasing demands of the fast-growing automotive industry, the United States Bureau of Mines comes forward with the declaration that the entirely preventable losses in the evaporation of gasoline from crude petroleum from the time the petroleum leaves the wells until it arrives at the refineries reaches a total of more than 300,000,000 gal. each year.

These are merely the preventive losses from evaporation alone and do not take into consideration other losses, many of which in part may be avoided. The total loss from evaporation amounts to more than 600,000,000 gal. of gasoline for the country, one-half of which, or 300,000,000 gal. of gasoline, may be saved.

The worst feature of this loss is the fact that the gasoline wasted is the most volatile and consequently the best quality. It follows that the prevention of this loss, which is economically possible, would not only increase the gasoline supply materially but would also increase the general standard of the gasoline.

The bureau shortly will issue careful directions to the oil men as to how this situation may be remedied.

It is estimated that the 600,000,000 gal. of gasoline lost through evaporation each year is worth as a national asset about $150,000,000.

Bureau of Standards Loses Many Scientists

The Bureau of Standards during September lost sixty-three members of its scientific staff through resignations. These resignations included such men as Mayo D. Hersey, physicist, in charge of the aviation instrument section; Christian Nusbaum, associate physicist of the magnetic measurement section; A. H. Taylor, associate physicist, in charge of the photometry and illuminating engineering section; Samuel R. Parsons, associate physicist, of the aëronautic power plant section; Victor R. Gage, mechanical engineer, of the aëronautic power plant section; G. M. Williams, associate engineer, of the cement, sand and stone section; William B. Brown, associate physicist, of the aëronautic power plant section; Herbert M. Freeman, associate physicist of the radio section; and Albert B. Peck, associate physicist of the cement, stone and sand section.

Citations by the Federal Trade Commission

The Federal Trade Commission has recently cited the following firms for unfair competition: The United States Color & Chemical Co., Inc., Boston, Mass., for giving cash commissions to employees of its customers to induce their employers to purchase respondent's products; the Seymour Chemical Co., Providence, R. I., for giving to boss finishers in textile mills cash commissions to influence such finishers to induce their employers to purchase the products of the respondent and refuse to buy competitors' goods.

Industry and the Tariff Commission

Need for careful study of industries and commerce before tariff rates are fixed was pointed out with unusual clearness in an address before the Southern Tariff Congress at New Orleans on Oct. 12 by William S. Culbertson, a member of the U. S. States Tariff Commission. "In our complex industrial system," said Mr. Culbertson in his address, "literally thousands of products, many of which are unknown to the average man, are affected by tariff legislation. Unless the data regarding them are gathered by specialists working day after day away from the stress of tariff hearings there can be no adequate understanding of the problems which they raise, either in detail or in their larger bearings on our national welfare."

Since the chemical industries are very vitally concerned with the tariff, a considerable portion of Mr. Culbertson's address dealt with chemical matters. Extracts from his remarks are as follows:

> The elimination of Germany from the world's markets by blockade, the diversion of the productive capacity of the Allies to war needs, and the interruption of shipping—each had its constructive effect on our industries.
>
> You may read in the reports of the Commission the records of this progress—of the production of surgical instruments, optical glass, laboratory glassware, scientific instruments, knitting-machine needles, potash, war metals such as tungsten and manganese, and thorium nitrate and incandescent gas mantles. You will find that while some crude barytes was produced in Missouri before the war, the Eastern manufacturers of lithopone—an important paint pigment—imported at that time this raw material from Germany. High prices opened additional barytes deposits in Georgia, Tennesee and Kentucky, which are now supplying not only the Eastern lithopone plants, but also the new barium chemical industry—another child of war conditions. You will learn of the rapid development of the ferro-alloy industries in the United States and of the competition which they are now facing from British sources. You—at least some of you—will no doubt be more interested in the story of vegetable oil production. The increase in the production of peanut oil is most striking. Domestic production increased from 60,533 gal. in 1912 to 12,791,200 gal. in 1918. Most of the imports since 1915 have come from the Orient. Peanut oil, however, is properly considered as a part of the larger problem of vegetable oils, of which there are, as you know, many. Cottonseed oil, coconut oil, soya bean oil and corn oil are only a few of the products that come in more or less close competition with peanut oil. We have attempted to analyze the whole situation in a survey as yet unpublished.
>
> The coal-tar chemical industry may be discussed at greater length as an example of these new developments, partly because it is the most striking and also because of its vital relation to our industrial and military security.
>
> In the meantime the American dye industry was beginning to grow. It was given a stimulus by the tariff act of Sept. 8, 1916, and from that time on until we entered the war the American consumers' needs of the simpler dyes were gradually met. The tariff law of Sept. 8, 1916, served its purpose in encouraging capital to enter the industry. The entrance of the United States into the war brought far-reaching changes in the dye business. On the one hand it restricted the supply of certain raw materials which were commandeered for munition purposes, and on the other hand it forced the dye industry to supply an unusual amount of dyes for the khaki uniforms and thereby decreased the supply of the ordinary colors used by civilians. The industry, however, continued to develop. The production of dyes had increased from about 7,000,000 lb. in 1914 to a total output in 1918 of 58,464,446 lb., valued at $62,026,390. The growth of this industry reads like a fairy tale.
>
> The signing of the armistice brought new problems for this new industry. During the war the German industry continued partial production and with its productive capacity intact was ready to attempt to regain its lost markets. The industry had grown in Japan, Great Britain, France and Switzerland. Competition of a serious character threatened the American industry from abroad. Congress has been urged to grant the industry additional protection, not merely because the industry is desirable in a diversified industrial nation, but also because it is vitally connected with the progress of medical science and with the problems of national defense.
>
> The foreign coal-tar dye industry is obviously only one phase of the larger question of the competitive status of foreign industries which we are trying to define. The chief competition with our industries will come in the future, as it has in the past, from Great Britain and continental Europe, but in many lines it will be some time before competition will reach its maximum strength. Speaking generally, wages in Europe, while still lower per man than in the United States, have increased relatively more. The difficulty of obtaining adequate fuel and essential raw materials also contributes to the abnormal cost of production. Transportation is demoralized. The advantage which depreciated currency gives the European producer in selling his goods abroad is very largely offset by the necessity of paying an exchange premium on imported products—coal, raw materials and semi-finished products.

Non-Metals Experiment Work

A limited amount of non-metals work is to be done at the new Bureau of Mines experiment station at Tuscaloosa, Ala. The principal work of the station is to be on byproduct and ferrous problems. The hope is expressed at the bureau that this station will be the nucleus of a much larger station which can give really comprehensive attention to byproducts.

The fear has been expressed that if any non-metals work were done at the Tuscaloosa station it would militate against the chance of securing a non-metals station next year. There was great disappointment among the chemical industries, which are large consumers of the non-metals, that they did not secure one of the experiment stations established this year. They are pointing out that the very limited amount of non-metals work being done at Tuscaloosa is not commensurate with the needs. Attention is being called to the fact that Tuscaloosa is just on the fringe of non-metals territory and is not the logical location for a non-metals station. The idea seems to be very generally held that Knoxville is a well-situated point for a full-fledged non-metals station.

A.S.M.E. Organizes Materials Handling Section

Four hundred members of the American Society of Mechanical Engineers have organized themselves into a Professional Section on Materials Handling and will provide primarily a common channel of intercourse among all the technical and industrial organizations co-operating in the solution of engineering problems connected with the handling and distribution of materials and products.

Probably the greatest economic need of civilization today is the devising of means and a more intelligent application of proper and co-ordinated methods whereby materials of one kind or another may be handled more swiftly and to better advantage.

This Section will aim to be a bureau of information—complete in its scope, specific in its knowledge of the physical and economic conditions and unbiased in its conclusions. This will be done by having special meetings on particular subjects, meetings jointly with other sections, other organizations or associations, and by taking part in all local and national problems relating to the purpose of this Section.

Imports and Exports of Chemicals

Exports of chemicals during August were practically in the same volume as the exports in August, 1919. On the other hand, imports of chemicals were nearly three times as great in August of 1920 as they were in August of 1919. Figures just compiled by the Bureau of Foreign and Domestic Commerce show that chemicals to the value of $21,189,777 were imported in August of this year. The imports in August, 1919, were valued at $7,964,651. The value of chemicals exported in August was $11,296,042. This compares with $11,121,531, the value of exports in August of 1919. For the first eight months of 1920 chemicals were exported to the value of $117,929,208. This is materially in excess of the value of chemicals exported during the first eight months of 1919, when they amounted to $86,-350,599. The imports during the first eight months of 1920 reached the large total of $147,634,259. This compares with $73,112,471 in the first eight months of 1919.

The total imports of coal-tar products during August, 1920, were valued at $1,608,672. Switzerland continues to be the heaviest exporter. During August the colors and dyes imported from Germany were valued at only $54,115. The imports of gums were high in August, amounting to 12,182,391 lb., as compared to 5,513,559 lb. in August of 1919. The same is true of potash. The imports in August of 1920 amounted to 3,389,114 lb. In August of 1919 the imports totaled only 757,102 lb.

The exports of acids were much lower in August of 1920 than they were in the preceding August. The value of the acids exported in August of 1920 was $365,639. In August the year before the exports of acids were valued at $519,871. There was a marked increase in the amount of dyes and dyestuffs exported in August, 1920. The total was $2,111,095. In August, 1919, the total was $1,172,087. In this particular China was our best customer, with the United Kingdom and Canada in second and third places respectively. The exports of soda in August, 1920, were valued at $2,156,-643. This compares with $1,771,283 in August, 1919.

Imports and exports of certain chemicals which do not move in large volume are shown by the following table:

EXPORTS CHEMICALS

	Aug., 1919	Aug., 1920
Copper, sulphate of (blue vitriol), lb	904,110	58,429
Formaldehyde (formalin), value	$122,978	$329,146
Glycerin, lb	391,154	257,057
Sal soda, lb	1,196,758	643,121

IMPORTS CHEMICALS

	Aug., 1919	Aug., 1920
Ammonia, muriate of, lb. (duty)	213,076	734,361
Fusel oil, or amylic alcohol and butylalcohol, lb. (duty)	461,443	355,133
Iodine, crude, or resublimed, lb. (free)	72,555	96,528
Lime, citrate of, lb. (duty)	262,483	444,692

Disabled Ex-Service Men Take Up Chemical Engineering

Disabled ex-service men to the number of 107 are pursuing courses in chemical engineering under the vocational education statute. At the end of August there were 1,949 disabled ex-service men taking engineering courses. This instruction is being given under the direction of the Federal Board for Vocational Education.

The work in chemical engineering is divided among forty-six schools, of which four are in New England, thirteen in the East, six in the South, fifteen in the Middle West, and eight in the West.

Apparatus Standards and Reagent Packages

Gas analysis apparatus standards and uniform packages for guaranteed reagents were discussed by two important conferences held in New York during the week of the Chemical Exposition. The committee on guaranteed reagents and standard apparatus appointed by the American Chemical Society is working actively under the chairmanship of W. D. Collins, and just now is giving particular attention to these subjects.

The appropriate size of units for purchase of reagent chemicals was discussed at a conference attended by representatives of manufacturers of guaranteed reagents and members of the committee. A plan was outlined by which the committee will take steps toward greater uniformity in ordering reagents. A tentative list of suggestions along this line will be drafted in the near future and submitted by publication for the criticism and comment of all interested parties.

The committee also called a special conference on gas analysis apparatus which was attended particularly by representatives of laboratory groups which make many gas analyses, both research and routine in nature. A program was adopted tentatively for preparing a set of uniform specifications for certain much used types of gas analysis apparatus. Tentative specifications will be adopted by this sub-committee and submitted to the main committee, which, it is expected, will publish them for comment and criticism before they are recommended for adoption.

Leather Waste for Heels in Germany

Commercial men who are interested in the leather trade are bringing out of Germany samples of a sole leather made from waste leather which is suitable for the manufacture of heels for shoes of all kinds, reports Consul-General Anderson of Rotterdam. The samples produced show a very firm, hard sole leather at first appearance suitable for any purpose for which sole leather is required. It is found upon close examination, however, that the leather is made up of pieces of waste leather which are likely to come apart when wet. The leather is manufactured from waste and scrap leather from old shoes or any other kind of leather waste, and is cleaned and soaked in water and then rolled into sheets and subjected to high pressure. The product has the appearance of a hard, dry, closely pressed sole leather, and for all purposes in shoe-making, when it can be protected to some extent from soaking or can be fastened together as in the nailing of a heel, it gives promise of being useful and economical. The leather can be had at the present time at 17 German marks per kilo, which at present exchange figures out roughly at about 12½c. gold per lb.

Manufacture of Superphosphates in Uruguay

The Administrative Council in Uruguay is considering a project for the establishment of a factory for the manufacture of superphosphates for use as fertilizers. A cheap supply of acid is guaranteed, and there is a great abundance of bones which are being exported at present at a low price. The project would prohibit the exportation of bones, but this is strongly objected to by the majority of the council, who are in favor of placing a high export duty on bones rather than prohibiting their exportation.

Swedish Market for Soda Sulphate

There is at this time a demand in Sweden for soda sulphate, the paper manufacturers generally being in need of supplies, reports Consul-General Murphy of Stockholm. If American manufacturers of chemicals can promptly satisfy the present demand at reasonable prices a steady market will be assured. The Swedish Paper Mills Association of Stockholm uses on an average 40,000 tons of soda sulphate a year, and the managing director states that orders will undoubtedly be forthcoming as soon as sure sources of supplies are located.

The manufacture of paper in Sweden dates back to the year 1573, when the first mill was established at Klippan. There are at this time eighty mills making all kinds of paper and pasteboard and 171 allied industries. The export of paper from Sweden in 1919 was 139,449 tons, as compared with 128,119 tons in 1918 and 189,612 in 1913.

Wood pulp for paper manufacture is likewise an important and flourishing Swedish industry, its future being assured by the vast timber supply of the country. In 1919 there was 807,761 tons of wood pulp exported from Sweden, the value of which was $13,649,000. The wood-pulp industry is likewise in need of a steady supply of soda sulphate, the home manufacture being by no means sufficient to supply the demand.

Fertilizer Imports Large

More fertilizer materials were imported in August of 1920 than were brought into the country during the first eight months of 1918 and nearly as much was brought in in that single month as was imported during the first eight months of 1919. The following figures are those of the Bureau of Foreign and Domestic Commerce. They show the value of fertilizer materials imported in August of 1920 to have been $3,953,893. In the preceding August these imports amounted to only $934,493. These imports were made up largely of bone dust, calcium cyanamide, guano, kainit, manure salts, and muriate and sulphate of potash.

There was some increase in the exports of fertilizer materials. The value of these materials exported in August, 1920, was $2,967,610. In August, 1919, these exports were valued at $2,318,420. Phosphate rock led the list of exports, with sulphate of ammonia in second place.

Shale-Oil Prospects in New Brunswick

As the demand for mineral oil is increasing, the visible supply diminishing and the oil companies scouring the world for new sources of supply, interest in oil shales has been revived, reports Consul Rasmusen of New Brunswick, Canada. The oil-shale areas of Albert County, New Brunswick, have recently been inspected by representatives of both British and American interests. According to the Dominion Department of Mines, samples taken from Albert County have yielded 60 imperial gal. to the ton. The concession for the development of natural gas in this same area is held by the New Brunswick Gas & Oil Fields (Ltd.), of Moncton, whose activities are confined to the development of natural gas, but it is possible that shale-oil production will be attempted in the near future either by this company or by other interests.

Decree Modifying the Price of Alcohol in France

The French Ministry of Industry, Labor and Provisions, in accord with the excise administration and the Minister of Finance, has just issued a decree modifying the prices of alcohol. The new prices, as from Sept. 1, are:

For motive power, manufacture of artificial silk and other use in which alcohol is entirely denatured, 100 deg., 3 fr. the liter (1 liter = 1.057 qt.).

For anatomical or scientific preparation, antiseptic and medical use, manufacture of pharmaceutical products, antiseptic and medicated cotton, felt and hats, manufacture of peptone, fulminate of mercury, collodion, artificial flowers, transparent soap, imitation leather, tannin, pyrotechnical products, smokeless powder and aniline colors, 100 deg., 5 fr. 20 centimes the liter.

For the manufacture of vinegar, to Oct. 31, 1920, 7 fr. 60 centimes; from November, 1920, 5 fr. 60 centimes the liter; manufacture of varnish, 5 fr. 72 centimes; perfumery, 13 fr.; university laboratories and official establishments, 21 fr. 80 centimes. For laboratories other than official, medical and pharmaceutical use, use in hospitals and clinics, and for fruits and confectionery and other uses, 21 fr. 85 centimes.

British Firm Makes Grant for Scientific Education

At a recent general meeting of the firm of Brunner Mond & Co. (Ltd.), chemical manufacturers, held in Liverpool there was passed a resolution "that the directors be and they are hereby authorized to distribute to such universities or other scientific institutions in the United Kingdom as they may select for the furtherance of scientific education and research the sum of £100,000 ($486,650) out of investment surplus reserve account."

Personal

W. M. BITTLE has accepted the position of chief chemist of the Duratex Co., Newark, N. J. He was formerly in charge of pyroxylin investigations.

HARRY A. DEUEL, assistant to the manager of the Minnequa Steel Works and for nineteen years in the employ of the company at Pueblo, has resigned to become chief engineer of the Atlantic Steel Co., Atlanta, Ga.

E. H. FRANTZ, who for the past two years has been plant chemist with the Combination Rubber Co., Bloomfield, N. J. has joined the chemical laboratory force of the Duratex Co., Newark, N. J.

BENJAMIN RICHARD JACOBS has resigned from the Bureau of Chemistry, U. S. Department of Agriculture, to become director of the National Cereal Products Labs., with offices in Washington, D. C.

DYKE V. KEEDY has returned from a six months' trip to Europe, visiting Italy, Dalmatia, Bosnia, France, Holland, Belgium and England.

Dr. ARTHUR I. KENDALL, dean of the Northwestern University Medical School, spoke recently before the Chicago Section of the American Chemical Society on "Bacteria as Chemical Reagents."

Dr. VERNON K. KRIEBLE, assistant professor of chemistry at McGill University, succeeds Dr. R. C. Riggs as Scoville professor of chemistry at Trinity College, Hartford, Conn.

WILSON H. LOW, formerly head chemist for the Cudahy Packing Co., Omaha, Neb., has removed to Los Angeles, where his address is 532 South Lorraine Blvd. Mr. Low and his former head assistant, John H. Show, who was a pioneer in the Nebraska potash industry, have opened an industrial laboratory in Los Angeles.

C. W. NEUSBAUM has resigned as chemist at the Holland plant of the American Radiator Co. to accept a position as assistant chemist for the Beech Nut Packing Co., Rochester, N. Y.

WALTER DILL SCOTT has been unanimously elected president of Northwestern University. Prof. Scott has previously held the chair of psychology at Northwestern since 1905. He served as Colonel on the General Staff during the war, being director of the committee on classification of army personnel. He was awarded the Distinguished Service Medal for this work.

Dr. F. W. TRAPHAGEN, professor of metallurgy in the Dakota School of Mines, has returned to Rapid City, S. D., after spending the summer in metallurgical research work for the Denver Metals Co. at its plant at Utah Junction, Col.

Dr. G. S. WHITBY and Dr. R. M. MCLEAN have been appointed joint professors of chemistry in the faculty of applied science, McGill University, Montreal.

Current Market Reports

The Iron and Steel Market

Pittsburgh, Pa., October 15, 1920.

It is now universally admitted that the iron and steel market is marked for a general readjustment. The prospect is accepted with much satisfaction by the majority of consumers, and with philosophic resignation by the producers, most of whom probably feel that they have had artificially high prices for a longer time than could reasonably have been expected.

While "readjustment" is universally admitted as being in prospect, or rather as actually begun, there are some divergences of opinion as to the character or course of the readjustment. A greatly decreased demand is admitted, but there is a difference of opinion as to what will follow in the matter of prices. It is all a question of prices of the independent steel producers, since no one suggests that the Steel Corporation's prices, which have been held to the Industrial Board schedule of March 21, 1919, will decline. Some steel producers insist that the independents will pursue the policy of filling the orders they now have, not seeking additional orders at cut prices, whereby the independent output is predicted to drop for the winter to a relatively low rate, possibly 60 per cent of capacity. Those who take what has already occurred in the market as indicative hold the opinion that independent prices will continue to sag, whereby in a few weeks or a very few months at the outside they will be down practically to the Steel Corporation level.

Illustrative of declines that have occurred and of the gaps between Steel Corporation and independent prices, it may be noted that plates, until recently held by independents at 3.25c. as minimum, have lately sold in small lots at 3.10c. and in at least one case at 3c., while the Steel Corporation's price is 2.65c. Structural shapes were held rather uniformly by independents at 3.10c. as minimum, but have recently sold first at 3c. and then at 2.90c., the Steel Corporation price being 2.45c. Merchant steel bars present a different case. Until lately there were some sellers at 3c., but 3.25c. seems to be the regular independent quotation now, mills having advanced their asking prices to protect contracts. The Steel Corporation price is 2.35c. In the past three or four weeks sheets have declined about half a cent a pound, the independent market being now approximately as follows: Blue annealed, 5c. to 5.25c.; black, 6.75c. to 7.25c.; galvanized, 8.50c. to 8.75c. The Steel Corporation's prices are 3.55c., 4.35c. and 5.70c. respectively, so that while sheets have declined very considerably they would still have a long distance to travel to meet the corporation level. In pipe there is a divergence of only about $7 a ton, the Steel Corporation having a 57½ per cent basing discount and the independents a 54 per cent basing discount.

PRODUCTION DECREASING

The September report of steel ingot production, presented by the American Iron and Steel Institute, shows a rate for the month of about 42,700,000 tons per annum, or precisely the rate shown for August, that rate having represented an increase of 7 per cent over the July rate. The increase then was due to improved transportation and other physical conditions, and there was a similar improvement in physical conditions for September. The failure of the statistics to reflect increased production in September confirms reports circulated in the month that some works were already curtailing output on account of lessened demand on the part of contract customers. This trend is more decided now, and it is regarded improbable that October will show as high a rate of production as September. Such a showing would be impressive, because normally October is a particularly good month for tonnage outputs on account of weather conditions.

PIG IRON WEAK

Pig iron has just given a remarkable exhibition of weakness after a display of strength in August that was plainly seen at the time to be largely artificial. In all districts except Chicago and Birmingham pig iron prices advanced in August, but there was nothing like the usual amount of buying and it was clear that prices were being pushed up by what might almost be called a mere whim of the furnacemen, consumers making purchases only for immediate requirements. September was a dull month in the market, and since the end of September it has been almost impossible to sell pig iron at all. A steel works that had been particularly provident in not buying ahead has been in the market for basic iron, which was firmly established by the August advances at $48.50 valley, or $50.46 delivered Pittsburgh. Its first purchase was at $46 valley, from a middle interest, and since then it has bought 1,500 tons, also from a middle interest, at $41.96 delivered, equal to $40 valley, while three producing interests had quoted on the basis of $42. In determining what is "the market price" the trade is usually disposed to ignore "resales" and from that viewpoint the market has not declined to $40, though the middle interest that sold 1,500 tons at $40 had 3,500 tons it was willing to sell at the figure. Certainly the market cannot be quoted at over $42 valley, when producers quote that price to a prospective buyer and do not effect sales. It was as late as last January that basic, on its upward movement, reached $40 valley, and thus there has been the abnormal experience of pig iron declining more rapidly than it had previously advanced. Bessemer iron remains nominally quotable at $48.50 valley, though a recent resale, of iron bought at $47, was at $46. Foundry is nominally quotable at $47 valley.

Declines in pig iron are susceptible of different interpretations. Pig iron had advanced more, relatively, than steel products, and thus a decline in pig iron might be regarded merely as a step towards equalization. The pig iron decline is notable on the other hand in that it occurs while Connellsville furnace coke for spot shipment is still $17. Such a price would justify a very high price for pig iron, and while it is eleven times the average price in May, 1915, and twenty times the price in 1894, it shows no definite signs of being about to recede, and it is, indeed, supported by the coal market, since coke at $17 represents little more than the market price of the coal involved plus a charge for conversion.

The Steel Corporation's unfilled obligations decreased during September by 430,234 tons to 10,374,804 tons, equivalent to about nine months of production at 90 per cent of capacity. The August decrease had been 313,430 tons.

The Chemical and Allied Industrial Markets

New York, October 16, 1920.

The dullness which has become almost habitual in this market continues uninterrupted, despite the unloading of small lots on the market that have been held in reserve. Buying interests, as in every other industry, are marking time and the period of this waiting having extended into weeks it seems as if steadiness is looked for rather than an advancement of price. The 1921 contract prices being put in effect by producers verify the opinion that there cannot very well be a general price recession for two reasons —(1) the cost of production has increased so much that an increase is inevitable; (2) in the two years of peace production has not even approached consuming demand, which will prevent the flooding of the market in the event of a surplus. The small amount of business transacted is mostly on odd lots for which concessions are being granted by second hands in order to clear their stocks.

Heavy Chemicals

All grades of *alum* remain firm, as very few offerings are being made. *Ammonia lump*, 5@6c., *potash lump*, 8¾@9½c., and *chrome lump*, 16@18c. per lb., are all producers' prices and have not changed for some time. One of the items receiving a sharp increase over 1920 contract prices is *soda ash*, which will be sold on a basis of 2c. per lb. f.o.b. works, compared with former manufacturer's price of 1¼@1½c. per lb. The spot market on the other hand declined sharply and the demand is not as keen as it was during the previous week, the new level being around $2.25@$2.50 per cwt. The new price on *caustic soda* for 1921 delivery is $4 per cwt. Inquiry has also fallen off on the spot material, which is available at $4.25@$4.50 per cwt., with no anxiety evidenced on the part of buyers to take advantage of these unusually low prices when compared with the recent $5.60@$6 price. The pressure being relieved, *sodium nitrite* is being offered around 12@14c. per lb. with enough material in the hands of producers to meet the rather low demand, which is especially felt in the spot market.

Coal-Tar Products

The crudes are the one sustaining branch of this market and the firmness which is noticeable in these items is caused by a shortage of material. The market in general remained quiet; among those to recede was *aniline oil*, now listed at 28@33c. per lb. The *salts* also dropped off 1c. to a low figure of 33c. per lb. Both grades of *beta naphthol* underwent a change during the period. *Sublimed*, which has been scarce, was hard to find under 90c., while the *technical*, with little or no interest displayed, fell off 5c. to 60@70c. per lb. The crudes have all remained firm, *phenol* being still available at Government price of 12c., while producers are quoting 1c. per lb. higher. Considerable quantities of *naphthalene, flake* and *balls*, having arrived from abroad, the recent high levels have dropped to 10½c. for flake and 12½c. for balls, with a very slow demand for both grades.

Crude Rubber

The consistent dullness of this market is occasionally broken by spasmodic activity which arises from the small demand for immediate requirements—but even these short interludes are not sufficient to make a favorable impression. The basic cause of this is the absolute lack of demand from tire manufacturers, who have been kept out of the market for the past few months by the acute conditions in their own industry. London reports some buying but also, as here, it is confined to small lots. The revival of the tire industry would certainly check the steady drop of all grades of rubber from a 54c. level for *plantation* to the present 25c. per lb.—but this is not expected for some time, and as a result the recession is nominal, as it is difficult to obtain figures on actual transactions.

Naval Stores

No improvement over last week's decidedly dull market has been noticed. In fact still lower prices are being heard, and despite this condition the local market has shown no tendency to buy. *Turpentine* fell off 10c., to $1.20 per gal., which practically amounts to a nominal figure, as there is so little material being sold. *Rosins* also fell off slightly, the cheaper grades being listed at $12.90 and WW at $13.25. This condition cannot go on much longer, as the supplies are not too plentiful and a general rise throughout the naval stores is looked for soon.

Oils

Linseed oil is the item of particular interest on the list, since it seems that it cannot be disposed of at any price. The new level of $1 per gal. is attracting as little interest among buyers as did the less favorable prices of recent dates. *Chinawood* held firm during the period and an increase in demand would help greatly to raise the current quotations of 17½@18c. per lb.

The Chicago Market

Chicago, Ill., October 13, 1920.

The long-continued period of weak prices shows no sign of an end, although frequent mention is made of the opinion that things will be better after election. In view of the fact that the present depression in all lines is the effect of powerful economic forces rather than political manipulation the correctness of this opinion is questionable. Steadily increasing imports to the extent that America's favorable trade balance was only $65,000,000 for the month of August indicate measurably reduced industrial activity for some time to come. It seems that the chemical industry can reasonably expect to share in this reduction of activity.

Purchasing is on a hand-to-mouth basis. The consensus among the members of the Purchasing Agents' Association, now in session here in Chicago, indorses this plan, on the ground that a general price reduction of from 25 to 50 per cent is in sight. Consideration must be given to the fact that the chemical industry has already had its shrinkage in most lines, and that but little further drop is economically possible.

Heavy Chemicals

The long-awaited announcement of contract prices on *caustic soda* and *soda ash* was forthcoming this week, the future of *sal soda* and *bleaching powder* being still in the dark. Spot offerings of *soda ash* range from $2 to $2.25 per cwt. with the few holders of second hands being forced to make offerings at a low figure by the reluctance of buyers. Contracts for 1921 are offered on a basis of $2.42 per cwt. for 58 per cent. *Caustic soda* contracts are announced at $5.06 per cwt. on 76 per cent. This is almost a dollar above current price, recent transactions in a dull market being reported at $4.15@$4.25. Some of the returned goods from Japan are going at $3.85 or lower. The scarcity of *bleaching powder* has been materially relieved and the price has abruptly declined to 6½@6¾c. per lb. *Sal soda*, unchanged at $2 per cwt., is in reasonable supply.

The market on *alcohol* begins to feel the effect of heightened production in that supplies are easier. Prices are unchanged, *ethyl* grade, 190 proof, being quoted at $5.65 per gal., *methyl*, 97 per cent, at $3.40 per gal., and *denatured* at $1.12. *Iron sulphate* (copperas) is easy in the hands of dealers at about $2.25 per cwt. for spot. Makers report a heavy volume of advance business at 2c. per lb. *Sodium bicarbonate*, under materially reduced demand, is going for $2.80 per cwt. or less, transactions being limited to small lots. *Chlorine* in liquid form is firmly held by spot traders at 9½c. per lb. Some contracts are being closed for 1921 at figures ranging around $8.75 per cwt.

Coal-Tar Products

Quiet prevails and, in general, a weak tone is felt in prices. *Aniline oil*, which felt a temporary strengthening a short time back, is again off, 27c. per lb. or less being the prevailing price. *Aniline salt* has also receded 2c. in the past three weeks, 34c. being today's price. *Phosgene*, for no apparent reason, has recently fluctuated sharply, the range being $1@$1.25 per lb.

Vegetable Oils

Linseed oil shows the effect of the constantly increasing visible supply of flaxseed by steady declines, the much-talked-of bogey of $1 having been reached. Spot carloads are offered at $1.05 and jobbers are selling small lots to the trade at $1.25, in barrels, 20c. lower than a fortnight ago. The resumption of production by some of the *corn oil* producers was immediately reflected by reductions in the market, offerings at 10c. per lb. for crude f.o.b. works going begging. Some business was closed at ¼@⅜c. less. The general condition of the corn products market is shown by recent reductions in the price of *corn sirup*, now being offered at $4.65 per cwt., against $4.90 at the opening of the season. *Peanut oil* slumped further to 11c. for Oriental, in tanks f.o.b. coast, and 16c. for edible, out of Chicago warehouses. Low market on competitive oils has driven the *soya bean* product to cover, coast quotation in sellers' tanks being only 9c. and small lot spots 13c.

Fertilizer Materials

Lower prices on live stock have materially reduced stockyards receipts, thereby decreasing production of fertilizer products. This is fortunate, as unusually warm October weather has forced demand to a low level. Few price recessions have been permitted by producers, and buyers are content to await developments. It seems probable that some further cuts must be made to induce trading. High-grade *ground blood* is quoted at $7.15 per unit, high-grade *ground tankage* at $6.85 and *renderer's unground tankage* at $5.50. *Ground steamed bone* is $35@$38 per ton, and *raw bone meal* about $50

The St. Louis Market

St. Louis, Mo., October 12, 1920.

The last two weeks have seen several fluctuations in the St. Louis market, some items advancing and other items declining slightly. Producers say that these changes have been brought about merely by the normal course of business and that they do not presage much of a change in the general tone of the market.

The market continues in good shape all around. Production is normal, demand continues satisfactory and stocks are such that practically all orders can be taken care of on normal deliveries. Contract business is moving along satisfactorily, numbers of contracts having been renewed since Oct. 1. Spot business is fairly strong. Producers are confident that the heavy chemical market is well under their control.

There has been a slight slackening of the demand for the 66-deg. *sulphuric acid*, but prices remain firm and producers look for an improvement shortly. This has been caused by closer buying on the part of the oil refineries. The 60-deg. grade is stronger and some lots have been quoted at as high as $16.50 per ton and 1¼c. per lb. in carboys. The average price ran between $16 and $16.50 per ton. The 66-deg. is quoted at $24 per ton and 1¾c. per lb. in carboys in carload lots. The 98 per cent acid remains firm at $25 per ton, f.o.b. works, with the market for it quiet. Oleum has registered an advance to $28.50 per ton from $27.50 and is in good demand.

Demand for *muriatic acid* continues very good, but due to liberal stocks the quotation on carload lots in carboys has dropped to 2@2¼c. per lb., a decline of about ¼c. The price on lots in bulk remains at $25 per ton.

Sodium bisulphate is in good supply, prices remaining unchanged. The demand continues, at from $5 to $6 per ton. Steel plants are said to be buying in this market freely and large orders have been received also from makers of animal foods.

Producers report a steadily increasing demand for *nitric acid*, but no increase in price has been registered. The quotations are $7 per cwt. on the 36-deg. and $10 on the 42-deg. Standard mixed acid, consisting of 36-deg. nitric and 61-deg. sulphuric, is firm at 1¼c. per lb. of each acid.

Zinc chloride remains at $4 per cwt. Phenol is still quoted at 12c. per lb. in lots of fifteen tons or more.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.65 – $0.75
Acetone	lb.	$0.15 – $0.20	.21 – .22
Acid, acetic, 28 per cent	cwt.	3.50 – 3.75	4.00 – 4.50
Acetic, 56 per cent	cwt.	6.50 – 7.50	8.50 – 9.50
Acetic, glacial, 99½ per cent, carboys	cwt.	14.00 – 16.00	16.25 –
Boric, crystals	lb.	.15½ – .16	.16½ – .19
Boric, powder	lb.	.15½ – .16½	.17 – .20
Citric	lb.	.78 – .80	.82 – .84
Hydrochloric (nominal)	cwt.	2.00 – 2.50	2.75 – 3.00
Hydrofluoric, 52 per cent (nominal)	lb.	.15 – .16	.16½ – .18
Lactic, 44 per cent tech	lb.	.10 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		–	–
Nitric, 40 deg	lb.	.06 – .07	.07½ – .08½
Nitric, 42 deg	lb.	.07½ – .08	.08½ – .09½
Oxalic, crystals	lb.	.45 – .50	.52 – .55
Phosphoric, Ortho, 50 per cent solution	lb.	.18 – .23	.24 – .25
Picric	lb.	.28 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.30 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	12.00 – 16.00	–
Sulphuric, 60 deg., drums	ton	–	–
Sulphuric, 66 deg., tank cars	ton	16.00 – 17.00	18.00 – 20.00
Sulphuric, 66 deg., drums	ton	26.00 – 28.00	–
Sulphuric, 66 deg., carboys	ton	–	–
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	37.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) drums	ton	28.00 – 30.00	38.00 – 42.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 – 35.00	40.00 –
Tannic, U. S. P	lb.	1.45 – 1.50	1.55 – 1.65
Tannic (tech.)	lb.	.60 – .70	.80 – .90
Tartaric, crystals	lb.	–	.74 – .77
Tungstic, per lb. of WO	lb.	–	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	5.50 – 5.75	6.00 – 7.00
Alcohol, Methyl (see methanol)		–	–
Alcohol, denatured, 188 proof (nominal)	gal.	–	1.12 – 1.15
Alcohol, denatured, 190 proof (nominal)	gal.	–	1.05 – 1.10
Alum, ammonia lump	lb.	.05 – .05½	05½ – .06
Alum, potash lump	lb.	– .08½	09 – .09½
Alum, chrome lump	lb.	16 – 17	.18 – .19
Aluminum sulphate, commercial	lb.	.04½ –	–
Aluminum sulphate, iron free	lb.	06 –	–
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.09¼ – .10¾	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.)	lb.	.35 – .35½	.36 – .38
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .18
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.15½ – .16½	.17 – .18
Ammonium chloride, granular (gray salammoniac)	lb.	.13 – .13½	.13½ – .14½
Ammonium nitrate	lb.	– 10	.11 – .14
Ammonium sulphate	lb.	.07 – .07½	.08½ –
Amylacetate	gal.	–	5.00 –
Amylacetate tech	gal.	–	4.75 – 5.25
Arsenic, oxide, lumps (white arsenic)	lb.	.13 – .14	.15 – .16
Arsenic, sulphide, powdered (red arsenic)	lb.	.16 – .17	.18 – .19
Barium chloride	ton	120.00–130.00	–
Barium dioxide (peroxide)	lb.	.21 – .23	.24 – .25
Barium nitrate	lb.	.10 – .12	.12½ – .13½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calcium hypochlorite)		–	–
Blue vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	.70 – .90	1.00 – 1.05
Calcium acetate	cwt.	3.50 – 3.55	–
Calcium carbide	lb.	.04½ – .04½	.04½ – .05½
Calcium chloride, fused, lump	ton	33.00 – 34.00	35.00 – 45.00
Calcium chloride, granulated	lb.	.02 – .02½	.03 – .03½
Calcium hypochlorite (bleaching powder)	cwt.	7.25 – 7.50	8.00 – 8.50
Calcium peroxide	lb.	–	1.50 – 1.70
Calcium phosphate, monobasic	lb.	–	.75 – .80
Calcium sulphate, pure	lb.	–	.25 – .30
Carbon bisulphide	lb.	.08 – .09	.10 – .11
Carbon tetrachloride, drums	lb.	.14 – .15	.16 – .17
Carbonyl chloride (phosgene)	lb.	–	1.25 – 1.50
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	.40 – .43	.44 – .47
Cobalt oxide	lb.	–	2.00 – 2.05
Copperas (see iron sulphate)		–	–
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	–	.65 – .70
Copper sulphate, crystals	lb.	.08 – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)		–	–
Epsom salt (see magnesium sulphate)		–	–
Ethyl Acetate Com. 85%	gal.	1.10 – 1.30	1.40 –
Ethy Acetate pure (acetic ether 98% to 100%)		–	1.75 –
Formaldehyde, 40 per cent (nominal)	lb.	.48 – .50	–
Fusel oil, ref	gal.	–	5.25 – 6.00
Fusel oil, crude (nominal)	gal.	–	–
Glauber's salt (see sodium sulphate)		–	–
Glycerine, C. P. drums extra	lb.	–	.26½ – .28½
Iodine, resublimed	lb.	4.30 – 4.35	4.40 – 4.45
Iron oxide, red	lb.	–	.03 – .20
Iron sulphate (copperas)	cwt.	2.00 – 2.25	2.35 – 2.75
Lead acetate, normal	lb.	–	.13½ – .16
Lead arsenate (paste)	lb.	.11 – .12	.13 – .17
Lead nitrate, crystals	lb.	–	.90 – 1.00
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.	–	1.50 –
Magnesium carbonate, technical	lb.	.12½ – .13½	.15 – .16
Magnesium sulphate, U. S. P	100 lb.	3.50 – 3.90	4.00 – 4.50
Magnesium sulphate, commercial	100 lb.	–	3.50 – 3.60
Methanol, 95%	gal.	–	3.25 – 3.30
Methanol, pure	gal.	–	3.50 – 4.50
Nickel salt, double	lb.	–	.14 – .16
Nickel salt, single	lb.	–	.13 – .14
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	.50 – .55	.60 – .65
Phosphorus, yellow	lb.	–	.35 – .37
Potassium bichromate	lb.	.34 – .36	.39 – .40

		Carlots		Less Carlots	
Potassium bitartrate (cream of Tartar)	lb.	$0 52 – $0 56		$0.57 – $0 58	
Potassium bromide, granular	lb.	–		.70 –	73
Potassium carbonate, U. S. P.	lb.	.50 –	.55	.56 –	60
Potassium carbonate, crude	lb.	.20 –	.21	.23 –	25
Potassium chlorate, crystals	lb.	.18 –	.18½	.19 –	20
Potassium hydroxide (caustic potash)	lb.	.27 –	.28	.29 –	33
Potassium iodide	lb.	–		3.35 –	3.60
Potassium nitrate	lb.	.17 –	.17½	.19 –	21
Potassium permanganate	lb.	.75 –	.80	.85 –	.95
Potassium prussiate, red	lb.	.85 –	.95	1.00 –	1.05
Potassium prussiate, yellow	lb.	.32 –	.36	.35 –	.40
Potassium sulphate (powdered)	ton	$240.00 –	255.00	–	
Rochelle salts (see sodium potas. tartrate)		–		–	
Salammoniac (see ammonium chloride)		–		–	
Sal soda (see sodium carbonate)		–		–	
Salt cake	ton	–		40.00 –	50.00
Silver cyanide (nominal)	oz.	–		1.25 –	
Silver nitrate (nominal)	oz.	–		.60 –	.62
Soda ash, light	100 lb.	–		2.25 –	2.50
Soda ash, dense	100 lb.	–		3.25 –	3.50
Sodium acetate	lb.	.10 –	.15	.20 –	.25
Sodium bicarbonate	100 lb.	2.85 –	2.95	3.00 –	3.50
Sodium bichromate	lb.	.22 –	.24	.26 –	.27
Sodium bisulphate (nitre cake)	ton	7.00 –	8.00	9.00 –	11.00
Sodium bisulphite Powered, U.S.P.	lb.	.08½–		.10 –	.11
Sodium borate (borax)	lb.	.09 –	.10	.11 –	.12
Sodium carbonate (sal soda)	100 lb.	2.06 –	2.10	2.15 –	2.25
Sodium chlorate	lb.	.11 –	.12	.12½ –	.14
Sodium cyanide, 96-98 per cent	lb.	.25 –	.30	.32 –	.35
Sodium fluoride	lb.	.18 –		.19 –	.20
Sodium hydroxide (caustic soda)	100 lb.	4.25 –	4.50	–	
Sodium hyposulphite	lb.	–		.03	.04
Sodium molybdate	lb.	2.50 –		3.25½–	
Sodium nitrate	100 lb.	3.00 –	3.25	3.75 –	4.00
Sodium nitrite	lb.	.13 –	.14	.15 –	.16
Sodium peroxide, powdered	lb.	.32 –	.33	.35 –	.40
Sodium phosphate, dibasic	lb.	.03¼–	.04½	.04½–	.05
Sodium potassium tartrate (Rochelle salts)	lb.	–		.39 –	.40
Sodium prussiate, yellow	lb.	.25 –	.27	.31 –	.32
Sodium silicate, solution (40 deg.)	lb.	.01½–	.01¾	.02 –	.02½
Sodium silicate, solution (60 deg.)	lb.	.02½–	.03	.04 –	.05
Sodium sulphate, crystals (Glauber's salt)	cwt.	2.25 –	2.50	2.60 –	2.75
Sodium sulphide, crystal, 60-62 per cent (conc)	lb.	.09½–	.10	.10½–	.11
Sodium sulphite, crystals	lb.	.04 –	0.4½	.04½–	.05
Strontium nitrate, powdered	lb.	.15 –	.18½	.19 –	.20
Sulphur chloride red	lb.	.08 –	.09	.10 –	.10½
Sulphur, crude	ton	16.00 –	20.00	–	
Sulphur dioxide, liquid, cylinders	lb.	.09 –		.10 –	.12
Sulphur (sublimed), flour	100 lb.	–		3.80 –	4.35
Sulphur, roll (brimstone)	100 lb.	–		3.40 –	3.90
Tin bichloride (stannous)	lb.	.42½–	.44	.45 –	.46
Tin oxide	lb.	–		.55 –	.65
Zinc carbonate, precipitate	lb.	.16 –	.18	.19 –	.20
Zinc chloride, gran.	lb.	.13 –	.13½	.13½–	.17
Zinc cyanide	lb.	.45 –	.49	.50 –	.60
Zinc dust	lb.	.12 –	.13	.13 –	.14
Zinc oxide, U. S. P.	lb.	.17 –	.25	–	
Zinc sulphate	lb.	.03½–	.03¾	.04 –	.06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.25	—	$1.35
Alpha-naphthol, refined	lb.	1.50	—	1.60
Alpha-naphthylamine	lb.	.45	—	.50
Aniline oil, drums extra	lb.	.28	—	.33
Aniline salts	lb.	.33	—	.36
Anthracene, 80% in drums (100 lb.)	lb.	.90	—	1.00
Benzaldehyde (f.f.c.)	lb.	2.00	—	2.10
Benzidine, base	lb.	1.35	—	1.40
Benzidine sulphate	lb.	1.15	—	1.25
Benzoic acid, U.S.P.	lb.	.85	—	.90
Benzoate of soda, U.S.P.	lb.	.80	—	.90
Benzene, pure, water-white, in drums (100 gal.)	gal	.35	—	.40½
Benzene, 90%, in drums (100 gal.)	gal	.33	—	.38½
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech.	lb.	.25	—	.35
Beta-naphthol benzoate (nominal)	lb.	3.50	—	4.00
Beta-naphthol, sublimed (nominal)	lb.	.90	—	.95
Beta-naphthol, tech (nominal)	lb.	.60	—	.70
Beta-naphthylamine, sublimed	lb.	2.25	—	2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.18	—	.19
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal	1.10	—	1.15
Cresylic acid, 95-97%, dark, in drums	gal	1.05	—	1.10
Cresylic acid, 50%, first quality, drums	gal	.65	—	.75
Dichlorbenzene	lb.	.07	—	.10
Diethylaniline	lb.	1.50	—	1.60
Dimethylaniline	lb.	.90	—	1.00
Dinitrobenzene	lb.	.30	—	.37
Dinitroclorbenzene	lb.	.32	—	.35
Dinitronaphthalene	lb.	.45	—	.55
Dinitrophenol	lb.	.40	—	.45
Dinitrotoluene	lb.	.38	—	.40
Dip oil, 25%, tar acids, car lots, in drums	gal	.38	—	.40
Diphenylamine (nominal)	lb.	.80	—	.85
H-acid (nominal)	lb.	1.90	—	2.05
Meta-phenylenediamine	lb.	1.25	—	1.30
Monochlorbenzene	lb.	.18	—	.20
Monoethylaniline	lb.	2.00	—	2.40
Naphthalene crushed, in bbls. (250 lb.)	lb.	.12	—	.14
Naphthalene, flake	lb.	.10½	—	.11
Naphthalene, balls	lb.	.12½	—	.13
Naphthionic acid, crude	lb.	.75	—	.85
Nitrobenzene	lb.	.14	—	.19
Nitro-naphthalene	lb.	.40	—	.50
Nitro-toluene	lb.	.18	—	.25
Ortho-amidophenol	lb.	3.25	—	4.25
Ortho-dichlor-benzene	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.80	—	.85
Ortho-nitro-toluene	lb.	.25	—	.40
Ortho-toluidine	lb.	.35	—	.38
Para-amidophenol, base	lb.	2.50	—	3.00
Para-amidophenol, HCl	lb.	2.50	—	3.00
Para-dichlorbenzene	lb.	.08	—	.12
Paranitroaniline	lb.	1.10	—	1.15
Para-nitrotoluene	lb.	1.25	—	1.40
Para-phenylenediamine	lb.	2.50	—	2.65
Para-toluidine	lb.	2.00	—	2.25
Phthalic anhydride	lb.	.60	—	.70
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	—	.20
Pyridine	gal.	2.00	—	3.50
Resorcinol, technical	lb.	4.25	—	4.50
Resorcinol, pure	lb.	6.25	—	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.45	—	.50
Salicylic acid, U. S. P.	lb.	.45	—	.50
Salol	lb.	.90	—	1.00
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.30	—	.35
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.20	—	.26
Sulphanilic acid, crude	lb.	.32	—	.35
Tolidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluene, in tank cars	gal.	.35	—	....
Toluene, in drums	gal.	.38½	—	.40½
Xylidines, drums, 100 gal.	lb.	.50	—	.65
Xylene, pure, in drums	gal.	.47½	—	.50½
Xylene, pure, in tank cars	gal.	.45	—	....
Xylene, commercial, in drums, 100 gal.	gal.	.32½	—	.35½
Xylene, commercial, in tank cars	gal.	.30	—	....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.33	—	$0.38
Beeswax, refined, light	lb.	.34	—	.37
Beeswax, white pure	lb.	.60	—	.65
Carnauba, No. 1, (nominal)	lb.	.90	—	.95
Carnauba, No. 2, regular (nominal)	lb.	.85	—	.86
Carnauba, No. 3, North Country	lb.	.35	—	.36
Japan	lb.	.18	—	.20
Montan, crude	lb.	.14	—	.15
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.09	—	.09½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.09½	—	.10
Paraffine waxes, refined, 118-120 m.p.	lb.	.11	—	.11½
Paraffine waxes, refined, 125 m.p.	lb.	.12½	—	....
Paraffine waxes, refined, 128-130 m.p.	lb.	.13	—	.15
Paraffine waxes, refined, 133-135 m.p.	lb.	.16	—	.17
Paraffine waxes, refined, 135-137 m.p.	lb.	.17½	—	.18½
Stearic acid, single pressed	lb.	.20	—	.21
Stearic acid, double pressed	lb.	.22	—	.23
Stearic acid, triple pressed	lb.	.24	—	.25

NOTE—Paraffine waxes very scarce.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.	$2.15
Pine oil, pure, dest. dist.	gal	1.80
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp. gr. 0.965-0.990	gal.	.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.	.35
Pinewood creosote, ref.	gal	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	280 lb.	$12.90	—	
Rosin E-I	280 lb.	12.90	—	13.25
Rosin K-N	280 lb.	13.15	—	....
Rosin W. G.-W. W.	280 lb.	13.25	—	....
Wood rosin, bbl.	280 lb.	12.50	—	....
Spirits of turpentine	gal.	1.20	—	....
Wood turpentine, steam dist.	gal.	....	—	....
Wood turpentine, dest. dist.	gal.	....	—	....
Pine tar pitch, bbl.	200 lb.	....	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	15.00
Retort tar, bbl.	500 lb.	15.00	—	15.50
Rosin oil, first run	gal.	.72	—	....
Rosin oil, second run	gal.	.55	—	....
Rosin oil, third run	gal.	.92	—	....

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.40
70-72 deg., steel bbls. (85 lb.)	gal	.38
68-70 deg., steel bbls. (85 lb.)	gal	.37
V. M. and P. naphtha, steel bbls. (85 lb.)	gal	.29

Crude Rubber

Para—Upriver fine	lb.	$0.26	—	$0.26½
Upriver coarse	lb.	.17	—	.18
Upriver caucho ball	lb.	.17½	—	.18½
Plantation—First latex crepe	lb.	.25	—	....
Ribbed smoked sheets	lb.	.24½	—	....
Brown crepe, thin, clean	lb.	.22½	—	....
Amber crepe No. 1	lb.	.22	—	....

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.16½	—	$0.18
Castor oil, AA, in bbls.	lb.	.17	—	.17
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.17½	—	.18
Cocoanut oil, Ceylon grade, in bbls.	lb.	.16½	—	.16½
Cocoanut oil, Cochin grade, in bbls (nominal)	lb.	.17½	—	.17
Corn oil, crude, in bbls.	lb.	.12	—	.13
Cottonseed oil, crude (f.o.b. mill)	lb.	.10½	—	.11
Cottonseed oil, summer yellow	lb.	.13	—	.14
Cotconseed oil, winter yellow	lb.	....	—	....
Linseed oil, raw, car lots (domestic)	gal.	1.07	—	....
Linseed oil, raw, tank cars (domestic)	gal.	1.00	—	....
Linseed oil, boiled, car lots (domestic)	gal.	1.09	—	....

Olive oil, commercial	gal.	3.00 —	3.50
Palm, Lagos	lb.	.10½ —	.10¾
Palm, bright red	lb.	—	—
Palm, Niger	lb.	.09½ —	.10
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.10¼ —	.12½
Peanut oil, refined, in bbls	lb.	.17 —	.18
Rapeseed oil, refined in bbls	gal.	1.30 —	1.45
Rapeseed oil, blown, in bbls	gal.	1.60 —	1.70
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.14 —	.14½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.10 —	.11
FISH			
Winter pressed Menhaden	gal.	$0.85 —	$0.90
Yellow bleached Menhaden	gal.	.87 —	.90
White bleached Menhaden	gal.	.90 —	.92
Blown Menhaden	gal.	1.05 —	...

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$22.00 —	$25.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	18.00 —	20.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	8.00 —	10.00
Barytes, ground, white, f.o.b. Cartersville, Ga.	net ton	23.00 —	25.00
Barytes, ground, off-color, f.o.b. Cartersville	net ton	16.00 —	19.00
Barytes, crude, 88%@94% ba., Cartersville	net ton	12.00 —	...
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, min. 98% ba., Missouri	net ton	11.00 —	11.25
Blanc fixe, dry	lb.	.05½ —	.06
Blanc fixe, pulp	net ton	60.00 —	80.00½
Casein	lb.	.15 —	.18
Chalk, domestic, extra light	lb.	.05 —	.06
Chalk, domestic, light	lb.	.04½ —	.05½
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	9.00 —	12.00
China clay (Kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (Kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (Kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (Kaolin), imported, lump	net ton	25.00 —	35.00
China clay (Kaolin), imported, powdered	net ton	30.00 —	60.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	7.50 —	8.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	30.00 —	35.00
Fuller's earth, granular, f.o.b. Fla.	net ton	25.00 —	...
Fuller's earth, powdered, f.o.b. Fla.	net ton	18.00 —	...
Fuller's earth, imported, powdered	net ton	35.00 —	40.00
Graphite (dust polish grade 30%) Ashland, Ala.	lb.	... —	.01
Graphite (dust facing grade 50%) Ashland, Ala.	lb.	... —	.02
Graphite, crucible, 80% carbon Ashland, Ala.	lb.	... —	.05
Graphite, crucible, 90% carbon Ashland, Ala.	lb.	... —	.10
Graphite, crucible, 85% carbon	lb.	... —	.08
Graphite, crucible, 88% carbon	lb.	... —	.09½
Graphite, crucible, 90% carbon	lb.	... —	.10½
Pumice stone, imported, lump	lb.	.04 —	.50
Pumice stone, domestic, lump	lb.	.06 —	...
Pumice stone, ground	lb.	.04 —	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	1.15 —	1.30
Shellac, orange superfine	lb.	1.10 —	1.20
Shellac, A. C. garnet	lb.	.90 —	.95
Shellac, T. N	lb.	.85 —	.95
Soapstone	ton	15.00 —	25.00
Tale, paper-making grades, f.o.b. Vermont	ton	12.00 —	22.00
Tale, roofing grades, f.o.b. Vermont	ton	9.50 —	15.00
Tale, rubber grades, f.o.b. Ve mont	ton	12.00 —	18.00
Tale, powdered, Southern, f.o.b. cars	ton	12.00 —	15.00
Tale, imported	ton	60.00 —	70.00
Tal-, Californin Talcum Powder grade	ton	20.00 —	35.00

Refractories

Bauxite brick, 56% Al., f.o.b. Pittsburgh	1,000	160
Chrome brick, f.o.b. Eastern shipping points	net ton	100–110
Chrome cement, 40-45% Cr_2O_3	net ton	55–60
Chrome cement, 40-45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	60–65
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	55–60
Fire clay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45–50
Magnesite brick, 9-in. straight	net ton	110
Magnesite brick, 9-in. arches, wedges and keys	net ton	121
Magnesite brick, soaps and splits	net ton	134
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	65–70
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	56–61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	55–60

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00 —	$250.000
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots	lb.	.18 —	.19
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.20 —	.21
Ferro-manganese, 76-80% Mn, domestic	gross ton	170.00 —	180.00
Ferro-manganese, 76-80% Mn, English	gross ton	170.00 —	175.00
Spiegeleisen, 18-22% Mn	gross ton	82.50 —	85.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo.	lb.	2.00 —	2.50
Ferro-silicon, 10-15%	gross ton	60.00 —	65.00
Ferro-silicon, 50%	gross ton	80.00 —	90.00
Ferro-silicon, 75%	gross ton	150.00 —	160.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	.90 —	1.05
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00 —	...
Ferro-vanadium, 30-40% per lb. of contained V.	lb.	6.50 —	8.50

Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe_2O_3, up to 20% silica, not more than 14% moisture	gross ton	$10.00 —	$11.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.70 —	.75
Chrome ore, 50%, max., Cr_2O_3, f.o.b. Atlantic Seaboard	unit	.75 —	.85
*Coke, foundry, f.o.b. ovens	net ton	... —	18.00
*Coke, furnace, f.o.b. ovens	net ton	16.50 —	17.00
*Coke, petroleum, refinery, Atlantic Seaboard	net ton	24.00	...
Fluor spar, lump, f.o.b. Tonuco, New Mexico	net ton	17.50 —	...
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	80.00 —	100.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01¼ —	85.02
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.60 —	.70
Manganese ore, chemical (MnO_2)	gross ton	80.00 —	100.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.70 —	75
Monazite, per unit of ThO_2	unit	$2.00 —	...
Pyrites, Spanish, fines ,c.i.f., Atlantic seaport	unit	.12 —	...
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport	unit	.16½ —	...
Pyrites, Spanish, run of mines, ci..f., Atlantic seaport	unit	.12 —	14
Pyrites, domestic, fines	unit	.12 —	14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	...
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	6.00 —	...
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	4.50 —	5.00
Uranium Ore (Carnotite) per lb. of U_3O_8	lb.	2.75 —	3.00
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.75 —	3.00
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium Ore, per lb. of V_2O_5 contained	lb.	1.25 —	...
Zircon, washed, iron free	lb.	.05 —	...

*Nominal

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	16.50
Aluminum, 98 to 99 per cent	34.80
Antimony, wholesale lots, Chinese and Japanese	7 12½@7 25
Nickel, ordinary (Ingot)	43.00
Nickel, electrolytic	45.00
Tin, 5-ton lots	49.50
Lead, New York, spot	8.00
Lead, E. St. Louis, spot	8.00
Zinc, spot, New York	8.50
Zinc, spot, E. St. Louis	7.70@8.05

OTHER METALS

Silver (Commercial)	oz.	$0.91½
Cadmium	lb.	1.40@1.50
Bismuth (500 lb. lots)	lb.	2.55
Cobalt	lb.	6.00
Magnesium (f.o.b. Niagara Falls)	lb.	1.75
Platinum	oz.	110.00
Iridium	oz.	400.00@450.00
Palladium	oz.	100.00
Mercury	75 lb.	72.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	29.50
Copper bottoms	37.25
Copper rods	38.00
High brass wire and sheets	30.25
High brass rods	27.00
Low brass wire and sheets	28.50
Low brass rods	29.00
Brazed brass tubing	38.25
Brazed bronze tubing	41.75
Seamless copper tubing	34.00
Seamless high brass tubing	33.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York — Current	New York — One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	14.00	17.00	13.00	14.00
Copper, heavy and wire	13.50	16.00	12.50	13.50
Copper, light and bottoms	12.00	14.00	11.00	12.00
Lead, heavy	6.75	4.75	6.00	6.50
Lead, tea	4.50	3.75	4.00	5.50
Brass, heavy	7.00	10.50	9.00	14.00
Brass, light	6.00	7.50	6.00	7.50
No. 1 yellow brass turnings	7.00	10.00	7.00	7.50
Zinc	4.50	5.00	4.00	5.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York — Current	New York — One Month Ago	New York — One Year Ago	Cleveland — Current	Cleveland — One Year Ago	Chicago — Current	Chicago — One Year Ago
Structural shapes	$4.58	$4.47	$3.47	$5.00	$3.37	$4.08	$3.47
Soft steel bars	4.73	4.62	3.37	4.50	3.27	3.98	3.37
Soft steel bar shapes	4.73	4.62	3.37		3.27	3.98	3.37
Soft steel bands	6.43	6.32	4.07	6.25			
Plates, ¼ to 1 in. thick	4.78	4.67	3.67	4.50	3.57	4.28	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Connecticut

ANSONIA — The Amer. Brass Co., 58 Liberty St., will build a 1-story, 340x400-ft. copper wire mill. Estimated cost, $725,000. Work will be done by day labor. Noted Oct. 15.

NEW HAVEN—The New Haven Pulp & Board Co., Green and East Sts., plans to build a 2-story factory addition. Estimated cost, $50,000. Fletcher Thompson, Inc., 1087 Broad St., Bridgeport, engr.

Illinois

CHICAGO—The By-Products Coke Corp. plans to build several buildings between 110th and 111th Sts. and Baltimore Ave.

Iowa

CEDAR RAPIDS—The Concrete Products Co. has awarded the contract for the construction of a 2-story factory and office building to the John Klepach Constr. Co., 1128 South 3d St. Estimated cost, $60,000.

Maine

GREAT WORKS—The Penobscot Chemical Fibre Co., 49 Federal St., Boston, has awarded the contract for the construction of a 34x45x109-ft. addition to its pulp and paper plant to the Aberthaw Constr. Co., 27 School St., Boston. Estimated cost, $125,000.

Massachusetts

FITCHBURG—The Falulah Paper Co., Falulah Rd., has awarded the contract for the construction of a 1-story, 40x100-ft. paper factory addition to Samuel M. Green Co., 293 Bridge St., Springfield, Mass. Estimated cost, $25,000.

WESTFIELD—The Vitrified Wheel Co. Emery St., will soon award the contract for the construction of a 2-story, 60x102-ft kiln building. Estimated cost, $30,000 Frost E. Chamberlain, 390 Main St., Worcester, archt.

Michigan

HAMTRAMCK (Detroit P. O.)—The Jeffrey Dewitt Co., Butler Ave. along the tracks of the Grand Trunk R.R., plans to build a 5-story factory for the manufacture of porcelain ware on Butler Ave. Estimated cost, $200,000.

Minnesota

CHISHOLM — The Bd. Educ. has purchased a site on 3d Ave. and Chestnut St. and plans to build a 3-story, 150x225-ft. vocational school on same. A chemical laboratory will be installed. Estimated cost, $250,000. Joseph Austin, pres.

New Jersey

GARFIELD—The De Mattia Bros. plan to build a 90x200-ft. rubber mill here. Estimated cost, $200,000. B. De Mattia, secy. J. F. Kelley, P. O. Bldg., Passaic, engr.

TRENTON—The New Jersey Tile Co., Muirheid Ave., plans to build a 60x200-ft. plant, to include 3 kilns, press room, slip house, etc., on Brunswick St. Estimated cost, $30,000. Karno Smith Co., Broad St. Bank, engr.

New York

BROOKLYN—The Amer. Marine Paint Co., Inc., 175 Dwight St., will build a 2-story factory on Richards St. Estimated cost, $75,000.

SYRACUSE — The Crown Oil Co., 310 West Jefferson St., is building a 1-story, 30x110-ft. gasoline and oil building on Van Rensselaer St. Estimated cost, $30,000.

Ohio

CLEVELAND—The Brass Co., c/o Allan Sogg, archt., 319 Hippodrome Bldg., plans to build a 1-story, 75x160-ft. foundry and machine shop. Estimated cost, $100,000.

Pennsylvania

BETHLEHEM—The Traveler Rubber Co. plans to build a 1-story, 25x35-ft. pumping station and a 1-story, 20x30-ft. cement house. Estimated cost, $10,000. J. O. Hunt, 114 North Montgomery St., Trenton, N. J., archt.

PHILADELPHIA—The Staybestos Mfg. Co., Linn and Armat Sts., has awarded the contract for the construction of a 2-story, 60x120-ft. factory for the manufacture of asbestos products on Berkley St. and Germantown Ave., to R. M. Peterson & Son, 5114 Germantown Ave. Estimated cost, $75,000.

Rhode Island

PROVIDENCE—The Revere Rubber Co., 355 Valley St., has awarded the contract for the construction of a 3-story addition to its rubber factory on Valley and Hemlock Sts., to the Cruise & Smiley Constr. Co., East Ave., Pawtucket. Estimated cost, $50,000.

Texas

TERRELL—The Chairman of the City Comn. will receive bids until Oct. 25 for the construction of a filtration plant capable of purifying 1,000,000 gal. of water every 24 hours.

Wisconsin

MILWAUKEE — Peter Bogenski, 1139 Grove St., plans to build a 1-story, 70x172-ft. factory for the manufacture of waterproof cement brick.

MILWAUKEE—The Red Star Yeast & Products Co., 27th and St. Paul Sts., will soon award the contract for the construction of a 2-story, 30x96-ft. yeast house. Estimated cost, $25,000. E. R. Liebert, University Bldg., archt. and engr. Noted Oct. 6.

PORT WASHINGTON—The Turner Mfg. Co. will soon receive bids for the construction of a 1-story, 60x180-ft. foundry, machine shop, etc., on Main St. Estimated cost, $150,000. W. A. Englehardt, mgr. F. D. Chase, Michigan Ave., Chicago, archt. and engr.

WAUWATOS—The Milwaukee Co. Bd. of Administration received bid for rebuilding the sewage disposal plant from the Lippmann Stone Co., 449 Clinton St., Milwaukee. $27,904. Noted Oct. 6.

Wyoming

CASPER—The city plans to install a manual-controlled chlorination system in the pumping house here. Estimated cost $1,500. F. S. Knittle, City Hall, engr.

New Brunswick

GRAND FALLS—The International Paper Co., Three Rivers, will receive bids in November for the construction of a pulp and paper plant here. Estimated cost, $1,000,000.

Nova Scotia

SYDNEY—The Dominion Iron & Steel Co. will soon award the contract for the construction of a brick-making plant.

Ontario

PORT ARTHUR—The Provincial Paper Mills, Ltd., has purchased the Port Arthur Pulp & Paper Co. and plans to expend $1,000,000 to improve and build additions to same for its own use. Noted Sept. 15.

TORONTO—The Anthes Fdry. Co., Ltd., 64 Jefferson Ave., has awarded the contract for the construction of a 1-story foundry on Jefferson Ave., to the Ramsay Contg. Co., 39 Indian Rd. Estimated cost, $20,000.

Quebec

MONTREAL—The Sherwin-Williams Co., Ltd., Centre St., has awarded the contract for the construction of a 3-story addition to its plant to Angli Norcress, Ltd., 65 Victoria St. Estimated cost, $62,000.

THREE RIVERS—The city will submit a bylaw to the ratepayers for the construction of a filtration plant and aqueduct. Estimated cost, $325,000. Z. Lambert, engr.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Ill.

AMERICAN ASSOCIATION OF ENGINEERS will hold a meeting on employment and education in the Congress Hotel, Chicago, on Nov. 12.

AMERICAN CERAMIC SOCIETY will hold its annual meeting the week of Feb. 21, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN ENGINEERING COUNCIL of the Federated American Engineering Societies will hold a meeting Nov. 18 and 19, 1920, in Washington, D. C. Headquarters will be at the New Willard Hotel.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its winter meeting at New Orleans, Dec. 6 to 9. Headquarters will be at the Hotel St. Charles.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15 to 19.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS' 1920 annual meeting will be held in the Engineering Societies' Building from Dec. 7 to 10 inclusive.

CANADIAN INSTITUTE OF MINING AND METALLURGY will hold its second annual Western meeting in Winnipeg, Man., on Oct. 25, 26 and 27. Headquarters will be at the Hotel Fort Garry.

ENGINEERING COUNCIL will hold its next meeting in Chicago, Thursday, Oct. 21.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12.

Industrial Notes

THE JEFFREY MANUFACTURING CO., Columbus, O., has opened an office at 1108 Marine Trust Bldg., Buffalo, in charge of H. W. Scott, formerly of the Columbus, O., office, in order to render more efficient service to western New York customers.

THE ELECTRIC FURNACE CONSTRUCTION Co., Philadelphia, Pa., announces that its first electrically heated core and mold drying oven has been put into operation at the Emery Steel Castings Co., Baltimore, Md. It is also announced that orders were received for the following Greaves-Etchells electric furnaces: Joliette Castings & Forgings, Ltd., Joliette, P. Q., 1 ton; Brennen Steel Castings Co., Cleveland, O., ½ ton. The furnace for the Bird-Archer Co., Cohoes, N. Y., for making special steel castings, has also been successfully started up.

MONSANTO CHEMICAL WORKS announces the establishment of a Chicago branch in the Marine Bldg., 209 North LaSalle St. This branch is opened with a view of serving its customers and friends in Chicago and surrounding territory more efficiently than could be done from St. Louis. A complete stock of the products manufactured by Monsanto Chemical Works will be carried at this branch, which will be managed by W. L. Filmer, who previously had charge of the flavors and condiments division of the St. Louis sales department.

A group of prominent steel foundries comprising: Electric Steel Co., Chicago, Ill.; Fort Pitt Steel Castings Co., McKeesport, Pa.; Isaac G. Johnson Co., Spuyten Duyvil, N. Y.; Lebanon Steel Foundry Co., Lebanon, Pa.; Michigan Steel Castings Co., Detroit, Mich., and the Sivyer Steel Castings Co., Milwaukee, Wis., have organized for the purpose of developing and perfecting higher standards in the production of steel castings. R. A. Bull, formerly vice-president of the Duquesne Steel Foundry Co., resigned from that position and has been appointed consulting metallurgist for the group mentioned. He will devote his entire time to preliminary research. His connection with the foundry industry covers a period of over twenty years, during which he has held important positions in foundries in St. Louis, Chicago, New York and Pittsburgh. The new organization will undoubtedly be a vital factor in the further improvement of the strength and quality of steel castings.